Notice No.1

Rules and Regulations for the Classification of Inland Waterways Ships, July 2021

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices.
Any corrigenda included in the Notice are effective immediately.
Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: November 2021

Amendments to	Effective date	IACS/IMO implementation (if applicable)
Part 1, Chapter 2, Section 1	1 January 2022	N/A
Part 3, Chapter 1, Section 4	1 January 2022	N/A
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Part 4, Chapter 3, Sections 1, 3, 4 & 5	1 January 2022	N/A
Part 4, Chapter 4, Section 1	1 January 2022	N/A

Lloyd's Register

Part 4, Chapter 5, Sections 1, 6, 7, 8, 10 & 11	1 January 2022	N/A
Part 4, Chapter 6, Sections 1, 3, 4, 5, 7, 11 & 12	1 January 2022	N/A
Part 4, Chapter 8, Section 7	1 January 2022	N/A
Part 4, Chapter 9, Sections 1, 3, 4, 5, 6, 7, 8, 9, 10 & 11	1 January 2022	N/A

Part 1
Chapter 2
Classification Regulations

■ *Section 1*
Conditions for classification

1.1 General

1.1.8 For ships, the arrangements and equipment of which are required to comply with the requirements of either the:

- European Agreement concerning the international carriage of dangerous goods by inland waterways (ADN); or
- ~~Règlement de visite des bateaux du Rhin 1995 (Rhine inspection regulations); or~~
- ~~EC Directive (2006/87/EC) DIRECTIVE of the EUROPEAN PARLIAMENT and of the COUNCIL of 12 December 2006 laying down technical requirements for inland waterway vessels; or~~
- European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN); or
- Any National regulations specified by the Government of the Flag State,

and applicable Amendments thereto, the Classification Committee requires the applicable Certificates to be issued by a National Administration, or by LR, or by an IACS Member when so authorised.

Part 3
Chapter 1
General

■ *Section 4*
National and International Regulations

4.1 International Regulations

4.1.1 Attention is drawn to the necessity to comply with National and International Technical and Operational Regulations applicable where the ship is registered or operating and which may also contain requirements which are outside classification as defined in these Rules, e.g.

- ~~The Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for inland waterway vessels (2006/87/EC).~~
- ~~The 'Rhine Inspection Regulations' of the Central Rhine Commission (CCNR).~~
- European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN).
- The Regulations concerning the European Agreement on the International carriage of dangerous goods by ~~River~~inland waterways (ADN).

Part 3,
Chapter 2
Materials

■ *Section 1*
Materials of construction

1.1 General

1.1.4 Where aluminium alloy is used for superstructures, deckhouses, hatch covers or other structural components, equivalent scantlings are to be derived~~.~~ in accordance with *Pt 3, Ch 2, 1.4 Aluminium*.

1.2 Grades of steel

1.2.1 The ships covered by these Rules are generally to be constructed of Grade ‘A’ or ‘AH’ steel. In highly stressed areas, however, grades of steel with higher levels of notch toughness (Grades ‘B’, ‘D’, ‘DH’, ~~or~~ ‘E’ or ‘EH’) may be required, dependent on the thickness of the material and the stress pattern associated with its location.

1.3 Steel

1.3.1 Steel having a specified minimum yield stress of 235 N/mm^2 is regarded as mild steel. Steel having a higher specified minimum yield stress is regarded as higher tensile steel.

1.3.2 For the determination of the hull girder section modulus, where higher tensile steel is used, a higher tensile steel factor, k_L, is given in *Table 2.1.1 Values of k_L*.

Table 2.1.1 Values of k_L

Specified minimum yield stress in N/mm^2	k_L
235	1,0
265	0,92
315	0,78
355	0,72
Note 1. Intermediate values by linear interpolation.	

1.3.3 The local scantling requirements of higher tensile steel plating, longitudinals, stiffeners and girders may be based on a *k* factor determined as follows:

$$k = \frac{235}{\sigma_O}$$

or 0,66, whichever is the greater.

where
σ_o = specific minimum yield stress in N/mm^2

1.4 Aluminium

1.4.1 The use of aluminium alloy is permitted for superstructures, deckhouses, hatch covers, helicopter platforms or other local components on board ships.

1.4.2 Except where otherwise stated in *Pt 3, Ch 8, 3 Aluminium erections*, equivalent scantlings are to be derived as follows:

(a) Plating thickness,

$$t_a = t_s \sqrt{k_a} c$$

(b) Section modulus of stiffeners,

$$Z_a = Z_s k_a c$$

where
c = 0,95 for high corrosion resistant alloy
= 1,00 for other alloys
$\boldsymbol{k_a = \frac{245}{\sigma_a}}$
t_a = thickness of aluminium plating

t_s = thickness of mild steel plating
Z_a = section modulus of aluminium stiffener
Z_s = section modulus of mild steel stiffener
σ_a = 0,2 per cent proof stress or 70 per cent of the ultimate strength of the material, whichever is the lesser.

1.4.3 In general, for welded structures, the maximum value of σ_a to be used in the scantlings derivation is that of the aluminium in the welded condition. However, consideration will be given to using unwelded values depending upon the weld line location and other heat affected zones, in relation to the maximum applied stress on the member (e.g. extruded sections).

1.4.4 A comparison of the mechanical properties for selected welded and unwelded alloys is given in *Ch 13, 8.3 Fabrication and welding 8.3.2* of the *Rules for the Manufacture, Testing and Certification of Materials*.

Part 3,
Chapter 3
Structural Design

■ *Section 2*
Rule structural concepts

2.6 Vertical extent of higher tensile steel

2.6.1 Higher tensile steel may be used for both deck and bottom structures or for deck structure only. Where fitted, it is to be used for the whole of the longitudinal continuous material for the following vertical distances:
(a) from the line of deck at side

$$Z_{ht} = (1 - k_L)Z_D$$

(b) from the top of keel

$$Z_{ht} = (1 - k_L)Z_B$$

where
k_L = higher tensile steel factor, *see Pt 3, Ch 2, Table 2.1.1 Values of k_L*
Z_D, Z_B = vertical distance, in metres, from the hull transverse neutral axis to the moulded deck line at side and to the top of keel respectively
Z_{ht} = vertical extent of higher tensile steel, in metres

2.7 Grouped stiffeners

2.7.1 Where stiffeners are arranged in groups of the same scantling, the section modulus requirement of each group is to be based on the greater of the following:
(a) the mean value of the section modulus required for individual stiffeners within the group;
(b) 90 per cent of the maximum section modulus required for individual stiffeners within the group.

~~2.6~~ 2.8 Principles for rounding off

Existing paragraph 2.6.1 has been renumbered 2.8.1.

Table 3.2.1 Principles for rounding off

Thickness in excess of whole number by		Rounded to
Over	Not exceeding	
-	~~0,2~~ 0,25 mm	0
~~0,2~~ 0,25 mm	~~0,7~~ 0,75 mm	0,5 mm
~~0,7~~ 0,75 mm	1,0 mm	1,0 mm

Existing sub-Section 2.7 has been renumbered 2.9.

■ *Section 3*
Structural ~~idealization~~ idealisation

3.2 Geometric properties of section

(Part only shown)
3.2.5 For symmetrical corrugations the following additional requirements are also to be complied with:

(a) the ratio b/t_p should not exceed ~~70~~ $70\sqrt{k}$

(b) the ratio c/t_p should not exceed ~~85~~ $85\sqrt{k}$

k = *see Pt 3, Ch 2, 1.1 General 1 1.3*

3.4 Calculation of hull section modulus

~~3.4.6 Where continuous hatch coamings are arranged, 80 per cent of the effective continuous material of the coaming with longitudinal stiffening may be included in the calculation of hull section modulus, and the lever z is to be measured to the effective height of the hatch coaming, i.e. moulded deck line at side amidships plus height of hatch coaming including camber.~~

3.4.6 Where trunk decks or continuous hatch coamings are effectively supported by longitudinal bulkheads or deep girders, they are to be included in the longitudinal sectional area when calculating the hull section modulus. The lever z_t is to be taken as:

$z_t = z_c(0{,}9 + 0{,}2\frac{y}{B})$ m but not less than *z*

where
y = horizontal distance from top of continuous strength member to the centreline of the ship, in metres
z = vertical distance from the neutral axis to the moulded deck line at side, in metres
z_c = vertical distance from the neutral axis to the top of the continuous strength member, in metres
z_c and *y* are to be measured to the point giving the largest value of z_t

~~3.4.7 Where continuous hatch coamings are supported by longitudinal bulkheads or equivalent structure, the sectional area of the effective height of the coaming may be fully included in the calculation of the section modulus.~~

~~3.4.8 Where a trunk deck is fitted, 100 per cent of the area of the trunk may be included in the calculation of hull section modulus, and the lever z is measured to the edge of trunk deck, see individual ship type Chapters.~~

Part 3,
Chapter 4
Longitudinal Strength

■ *Section 1*
Application

1.1 General

1.1.2 For the determination of the longitudinal strength, design bending moments are to be calculated for all ships with a length, *L*, exceeding ~~40~~ 65 m. The methods for calculation of design bending moments are given in *Pt 3, Ch 4, 5 Design bending moments*. The determination of longitudinal strength of ships with a length, *L*, of ~~40~~ 65 m and less is generally not required.

■ *Section 2*
General

2.1 Loading conditions for determination of design bending moments

2.1.2 For ships designed, modified and/or arranged for navigation in Zones 3, 2 or 1 or for service extension, the additional wave bending moment and wave shear force for the particular zone or service extension area are to be added to the still water bending moment and shear force calculated for the conditions (a), (b) and ~~(b)~~(c) of *Pt 3, Ch 4, 2.1 Loading conditions for determination of design bending moments 2.1.1* to obtain the actual maximum bending moment and shear force for calculation of the required hull section modulus.

~~2.1.3 For ships sailing in Zone 3, *see Pt 1, Ch 2, 2.1 Definitions 2.1.4*, it is acceptable to calculate the bending moments and shear forces for the still water condition only, neglecting the wave bending moments and wave shear forces.~~

Existing paragraphs 2.1.4 and 2.1.5 have been renumbered 2.1.3 and 2.1.4.

■ *Section 4*
Hull section modulus

4.1 General

4.1.1 The hull section modulus required over 0,5*L* amidships is to be determined from the design bending moments, sagging or hogging, *see Pt 3, Ch 4, 5 Design bending moments*, considering the additional wave bending moment in *Pt 3, Ch 4, 6.2 Design vertical wave bending moments* in association with a permissible stress as indicated in ~~*Pt 3, Ch 4, 6 Maximum permissible stresses*~~ *Pt 3, Ch 4, 6.5 Permissible hull vertical bending stresses*.

4.1.3 Outside 0,5*L* amidships, as a minimum, hull girder bending strength checks are to be carried out at the following locations:
(a) In way of the forward end of the engine room.
(b) In way of the forward end of the foremost cargo hold.
(c) At any locations where there are significant changes in hull cross-section.
(d) At any locations where there are changes in the framing system.

■ *Section 5*
Design bending moments

5.1 General

~~5.1.3 The design bending moments of ships with a length, *L*, between 40 m and 65 m may be determined using the formulae given in this Section. Alternatively the design bending moments may be determined using an approved direct calculation system.~~

■ *Section 6*
~~Maximum permissible stresses~~ Hull bending strength

Existing sub-Section 6.1 has been renumbered 6.5.

6.1 Symbols

6.1.1 The symbols used in this Section are defined as follows:
f_1 = ship service factor
f_2 = wave bending moment factor
M_S = design still water bending moment, sagging (negative) and hogging (positive), in kN m, to be taken negative or positive according to the convention given in *Pt 3, Ch 4, 6.3 Design still water bending moments*
$\overline{M_S}$ = maximum permissible still water bending moment, sagging (negative) and hogging (positive), in kN m
M_W = design hull vertical wave bending moment, sagging (negative) and hogging (positive), in kN m, to be taken negative or positive according to the convention given in *Pt 3, Ch 4, 6.2 Design vertical wave bending moments*
Z_C = actual hull section modulus, in m^3, at continuous strength member above strength deck, calculated with the lever specified in *Pt 3, Ch 3, 3.4 Calculation of hull section modulus*
Z_D, Z_B = actual hull section moduli, in m^3, at strength deck and keel respectively, *see Pt 3, Ch 3, 3.4 Calculation of hull section modulus*
σ = permissible combined stress (still water plus wave), in N/mm^2, *see Pt 3, Ch 4, 6.5 Permissible hull vertical bending stresses*
σ_D, σ_B = maximum hull vertical bending stress at strength deck and keel respectively, in N/mm^2
z = vertical distance from the hull transverse neutral axis to the position considered, in metres

z_M = vertical distance, in metres, from the hull transverse neutral axis to the minimum limit of higher tensile steel, as defined in *Pt 3, Ch 3, 2.6 Vertical extent of higher tensile steel*, above or below the neutral axis as appropriate.

6.2 Design vertical wave bending moments

6.2.1 The appropriate hogging or sagging design hull vertical wave bending moment at amidships is given by the following:

$M_w = f_1 \, f_2 \, M_{wo}$

where

$M_{wo} = 0{,}1 C_1 C_2 L^2 B(C_b + 0{,}7)$ kN m
$\quad = (0{,}0102 C_1 C_2 L^2 B(C_b + 0{,}7)$ tonne-f m)
C_b = is to be taken not less than 0,60
C_1 = is given in *Table 4.6.1 Wave bending moment factor*
C_2 = 1 (also defined in *Pt 3, Ch 4, 6.2 Design vertical wave bending moments 6.2.2* at other positions along the length L)
f_1 = ship service factor. For Zone 3 f_1 = 0,100, for Zone 2 f_1 = 0,207, for Zone 1 f_1 = 0,311
f_2 = −1,1 for sagging (negative) moment
$f_2 = \frac{1{,}9C_b}{(C_b + 0{,}7)}$ for hogging (positive) moment

Table 4.6.1 Wave bending moment factor

Length L, in meters	Factor C_1
< 90	$0{,}0412L + 4{,}0$
90 to 135	$10{,}75 - \left(\frac{300 - L}{100}\right)^{1{,}5}$

6.2.2 The longitudinal distribution factor, C_2, of wave bending moment is to be taken as follows:

- 0 at the aft end of L;
- 1,0 between 0,4L and 0,65L from aft;
- 0 at the forward end of L.

Intermediate values are to be determined by linear interpolation.

6.2.3 For harbour the condition, a higher permissible still water bending moment can be assigned based on a reduced vertical wave bending moment given by:
(a) For harbour condition,

$M_w = 0{,}5 f_1 f_2 M_{wo}$

6.3 Design still water bending moments

6.3.1 The design still water bending moment, M_s, hogging and sagging is the maximum moment calculated from the loading conditions, given in *Pt 3, Ch 4, 6.3 Design still water bending moments 6.3.3*, and is to satisfy the following relationship:

$|M_s| \leq |\overline{M_s}|$

6.3.2 Still water bending moments are to be calculated along the ship length. For these calculations, downward loads are to be taken as positive values and are to be integrated in the forward direction from the aft end of L. Hogging bending moments are positive.

6.3.3 In general, the following loading conditions, based on amounts of bunkers, fresh water and stores at departure and arrival, are to be considered:

(a) Homogeneous loading conditions, at maximum draught.
  (i) For non-propelled carriers, the vessel is considered to be homogeneously loaded at its maximum draught, without supplies nor ballast.
  (ii) For self-propelled carriers, the vessel is considered to be homogeneously loaded at its maximum draught with 10 per cent of supplies (without ballast).
(b) Ballast conditions.
(c) Special loading conditions, e.g. container or light load conditions at less than the maximum draught, heavy cargo, empty holds or non-homogeneous cargo conditions, deck cargo conditions, etc. where applicable.
(d) Loading/unloading in two runs or in one run according to the defined loading sequence in *Pt 3, Ch 4, 2.3 Longitudinal strength categories*. The vertical wave bending moment for the harbour condition in *Pt 3, Ch 4, 6.2 Design vertical wave bending moments 6.2.3* might be used in case.
(e) Any other loading condition likely to result in high bending moments and/or shear forces (including docking conditions, as appropriate).

6.3.4 Where the amount and disposition of consumables at any intermediate stage of the voyage are considered more severe, calculations for such intermediate conditions are to be submitted in addition to those for departure and arrival conditions. Also, where any ballasting and/or de-ballasting is intended during the voyage, calculations of the intermediate condition just before and just after ballasting and/or de-ballasting any tank are to be submitted and, where approved, included in the loading manual for guidance.

6.4 Permissible still water bending moments

6.4.1 The permissible still water bending moments sagging and hogging are to be taken as the lesser of the following:

(a) $|\overline{M}_{\mathrm{s}}| = \sigma Z_{\mathrm{D}} \times 10^3 - |M_{\mathrm{w}}|$ kN m

(b) $|\overline{M}_{\mathrm{s}}| = \sigma Z_{B} \times 10^3 - |M_{\mathrm{w}}|$ kN m

where

σ = the permissible combined stress in N/mm^2 as given in *Pt 3, Ch 4, 6.5 Permissible hull vertical bending stresses*. M_{w} is the design wave bending moment, sagging or hogging as appropriate, in accordance with *Pt 3, Ch 4, 6.2 Design vertical wave bending moments*.

~~6.1 General (Zone 3)~~ 6.5 Permissible hull vertical bending stresses

~~6.1.1~~ 6.5.1 ~~The permissible stresses to be used for the calculation of the hull section modulus are:~~ The permissible combined (still water plus wave) stress for hull vertical bending, σ, is given by:

(a) Longitudinal bending:

~~σ_s = 137 N/mm^2 (14 kgf /mm^2)~~

$$\sigma_{\mathrm{s}} = \frac{175}{k_{\mathrm{L}}} \text{ N/mm}^2$$

(b) In ships with continuous hatch coamings:

Longitudinal bending at top of coaming

~~σ_s = 137 N/mm^2 (14 kgf /mm^2)~~

$$\sigma_{\mathrm{s}} = \frac{175}{k_{\mathrm{L}}} \text{ N/mm}^2$$

~~6.1.2~~ 6.5.2 The permissible combined stress σ_c being the sum of stresses due to longitudinal bending and local loading ($\sigma_c = \sigma_s + \sigma_b$) is:

~~σ_c = 177 N/mm^2 (18 kgf /mm^2)~~

$$\sigma_{\mathrm{c}} = \frac{215}{k_{\mathrm{L}}} \text{ N/mm}^2$$

Existing paragraph 6.1.3 has been deleted.

Existing paragraph 6.1.4 has been renumbered 6.5.3.

■ *Section 7*
Hull buckling strength

7.1 Application

7.1.1 These requirements apply to plate panels and longitudinals subjected to hull girder compression based on design values for still water and wave bending moments.

7.2 Symbols

7.2.1 The symbols used in this Section are defined as follows:

d_t = standard addition for corrosion, *see Table 4.7.1 Corrosion additions for one side exposure, d_{t1} or d_{t2}*

s = spacing of secondary stiffeners, in mm. In the case of symmetrical corrugations, s is to be taken as b or c in *Figure 3.3.3 Dimensions and symbols for corrugated bulkheads*, whichever is the greater

t = as built thickness of plating, stiffener flange and web used in *Table 4.7.1 Corrosion additions for one side exposure, d_{t1} or d_{t2}*, in calculating standard addition d_t, in mm

t_p = as built thickness of plating less standard addition d_t, in mm (i.e. $t_p = t - d_t$)

E = modulus of elasticity, in N/mm^2
= 206000 N/mm^2 for steel
= 69000 N/mm^2 for aluminium alloys

S = spacing of primary members, in metres

σ_o = specified minimum yield stress, in N/mm^2

σ_A = design longitudinal compressive stress in N/mm^2

σ_{CRB} = critical buckling stress in compression, in N/mm^2, corrected for yielding effects

σ_E = elastic critical buckling stress in compression, in N/mm^2

7.3 Corrosion additions

7.3.1 The designer may define values of corrosion additions greater than those specified in *Pt 3, Ch 4, 7.3 Corrosion additions 7.3.2*.

7.3.2 The corrosion addition for each of the two sides of a structural member for steel other than stainless steel, t_{d1} or t_{d2}, is specified in *Table 4.7.1 Corrosion additions for one side exposure, d_{t1} or d_{t2}*.

7.3.3 For plating with a net thickness greater than 8 mm, the total corrosion addition t_d, in mm, for both sides of the structural member is obtained by the following formula:

$t_d = t_{d1} + t_{d2}$

7.3.4 For plating with a net thickness less than or equal to 8 mm, the smaller of the following values is to be applied for the total corrosion addition t_d:

(a) 20 per cent of the gross thickness of the plating, or
(b) $t_d = t_{d1} + t_{d2}$.

7.3.5 For an internal member within a given compartment, the total corrosion addition t_d is obtained from the following formula:

$t_d = 2t_{d1}$

7.3.6 When a structural element is affected by more than one value of corrosion addition (e.g. plate in a dry bulk cargo hold extending into the double bottom), the scantling criteria are generally to be applied considering the severest value of corrosion addition applicable to the member.

7.3.7 For structural members made of stainless steel or aluminium alloys, the corrosion addition is to be taken equal to 0,25 mm, for one side exposure ($t_{d1} = t_{d2} = 0{,}25$ mm).

7.4 Elastic critical buckling stress

7.4.1 The elastic critical buckling stress of plating is to be determined from *Table 4.7.2 Elastic critical buckling strength of plating*.

7.4.2 The elastic critical buckling stress of longitudinals is to be determined from *Table 4.7.3 Elastic critical buckling strength of longitudinals*.

7.4.3 Alternatively, the elastic critical buckling stress of plating and longitudinals may be assessed in accordance with Chapter 3 of the ShipRight Procedure *Additional Calculation Procedures for Longitudinal Strength*.

7.5 Design stress

7.5.1 Design longitudinal compressive stress, σ_A, is to be determined in accordance with *Pt 3, Ch 4, 6 Hull bending strength*:

for structural members above the neutral axis,

$$\sigma_{\mathrm{A}} = \sigma_{\mathrm{D}} \frac{z}{z_{\mathrm{D}}}$$

for structural members below the neutral axis,

$$\sigma_{\mathrm{A}} = \sigma_{\mathrm{B}} \frac{z}{z_{\mathrm{B}}}$$

σ_D based on sagging moment and σ_B based on hogging moment are determined by the hull moment of inertia.

where
z = vertical distance from the hull transverse neutral axis to the position considered, excluding deck camber, in metres
z_D, z_B = vertical distances from the hull transverse neutral axis to the deck and keel respectively, in metres

For initial design purposes, the hull transverse neutral axis may be taken at a distance $\frac{D}{2}$ above keel, where D is the depth of the ship, in metres, as defined in *Pt 3, Ch 1, 6 Definitions*.

Table 4.7.1 Corrosion additions for one side exposure, d_{t1} or d_{t2}

Compartment type		General Note 1d
Ballast tank		1,00
Cargo tank and fuel oil tank	Plating of horizontal surfaces	0,75
	Plating of non-horizontal surfaces	0,50
	Ordinary stiffeners and primary supporting members	0,50
Dry bulk cargo hold	General	1,00
	Inner bottom plating Side plating for single hull vessel Inner side plating for double hull vessel Transverse bulkhead plating	1,25

	Frames, ordinary stiffeners and primary supporting members	0,50
Hopper well of dredging vessels		1,75
Accommodation space		0,00
Compartments and areas other than those mentioned above		0,50
Note 1. Corrosion additions are applicable to all members of the considered item.		

Table 4.7.2 Elastic critical buckling strength of plating

Mode	Elastic critical buckling stress, N/mm^2
(a) Compression of plating with longitudinal stiffeners (parallel to compressive stress), *see* Note	$\sigma_E = 3{,}6E\left(\frac{t_p}{s}\right)^2$
(b) Compression of plating with transverse stiffeners (perpendicular to compressive stress), *see* Note	$\sigma_E = 0{,}9c\left[1+\left(\frac{s}{1000S}\right)^2\right]^2 E\left(\frac{t_p}{s}\right)^2$ *c* = 1,3 when plating stiffened by floors or deep girders = 1,21 when stiffeners are built-up profiles or rolled angles = 1,10 when stiffeners are bulb plates = 1,05 when stiffeners are flat bars
Note: Where the elastic critical buckling stress, as evaluated from (a) or (b), exceeds 50% of the specified minimum yield stress of the material, the corrected critical buckling stresses in compression (σ_{CRB}) are given by: $\sigma_{CRB} = \sigma_E$ when $\sigma_E \leq \frac{\sigma_o}{2}$ N/mm^2 $= \sigma_o\left(1-\frac{\sigma_o}{4\sigma_E}\right)$ when $\sigma_E > \frac{\sigma_o}{2}$ N/mm^2	

Table 4.7.3 Elastic critical buckling strength of longitudinals

Mode	Elastic critical buckling stress, N/mm^2
(a) Column buckling (perpendicular to plane of plating) without rotation of cross section, *see* Note 1	$\sigma_E = 0{,}001E\frac{I_a}{A_t S^2}$
(b) Web buckling, *see* Notes 1 and 3 (flat bars are excluded)	$\sigma_E = 3{,}8E\left(\frac{t_W}{d_W}\right)^2$
Symbols and parameters	
d_w = web depth, in mm t_w = as built web thickness less standard addition d_t as specified in *Table 4.7.1 Corrosion additions for one side exposure, d_{t1} or d_{t2}*, in mm, (i.e. $t_w = t - d_t$). For webs in which the thickness varies, a mean thickness is to be used A_t = cross-sectional area, in cm^2, of longitudinal, including attached plating, taking account of standard additions, *see* Note 4 I_a = moment of inertia, in cm^4, of longitudinal, including attached plating, taking account of standard additions, *see* Note 4 All other symbols as defined in *Pt 3, Ch 4, 7.2 Symbols 7.2.1*.	
Note 1. Where the elastic critical buckling stress, as evaluated from (a) or (b), exceeds 50% of the specified minimum yield stress of the material, the corrected critical buckling stress in compression (σ_{CRB}) is given by: $\sigma_{CRB} = \sigma_o\left(1-\frac{\sigma_o}{4\sigma_E}\right)$ N/mm^2 Note 2. For flanges on angles and T-sections of longitudinals, the following requirement is to be satisfied: $\frac{b_f}{t} \leq 15$ for angles, $\frac{b_f}{t} \leq 30$ for 'Tee' profiles where *t* = as built flange thicknesses, in mm Note 3. The area of attached plating is to be calculated using actual spacing of secondary stiffeners.	

7.6 Scantling criteria

7.6.1 The corrected critical buckling stress in compression, σ_{CRB}, of plate panels and longitudinals, as derived from *Table 4.7.2 Elastic critical buckling strength of plating* and *Table 4.7.3 Elastic critical buckling strength of longitudinals*, is to satisfy the following:

$\sigma_{CRB} \geq \beta\ \sigma_A$

where
- β = 1,05 for plating and for web plating of longitudinals (local buckling)
- β = 1,1 for longitudinals

Part 3,
Chapter 5
Fore End and Aft End Structure

■ *Section 2*
Hull envelope plating

2.2 Keel

(Part only shown)

Table 5.2.1 Shell plating forward and aft

Location	Scantlings
(3) Bottom shell, bilge and side shell plating forward and aft of the respective shoulders (a) Forward of 0,075*L* from the F.P. and aft of 0,075*L* from the A.P. (end thickness)	The greater of: ~~$t = (5{,}6 + 0{,}054L)\sqrt{s}$ mm~~ $t = (5{,}6 + 0{,}054L)\sqrt{sk}$ mm *t* = 10*s* mm
Symbols	
L, *s* and *t* as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* *k* = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*	

2.6 Deck plating

(Part only shown)

Table 5.2.2 Deck plating forward and aft

Location	Thickness, in mm
(1) Forward of 0,075*L* from the F.P. and aft of 0,075*L* from the A.P. on the strength deck	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$~~ $t = (5{,}6 + 0{,}039L)\sqrt{sk}$ *t* = 10*s* ~~*t* = 3,5~~
(2) Between 0,075*L* and 0,25*L* from the F.P. and between 0,075*L* and 0,25*L* from the A.P. on the strength deck	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$~~ $t = (5{,}6 + 0{,}039L)\sqrt{sk}$ *t* = 10*s* ~~*t* = 3,5~~ *t* = the taper thickness *see* Note
Symbols	
L, *s* and *t* are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* *k* = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*	

■ *Section 3*
Bottom structure

3.2 Girders

(Part only shown)

Table 5.3.1 Single bottom construction forward and aft

Item	Parameter	Requirements
Transverse framing system		
(1) Floors	Web depth at centreline Modulus Web thickness	$d_f = 40l_f$ mm $Z = 6 \times k \times D_{-1} \times s \times l_f^2$ cm^3 ~~$t = 0{,}01d_f + 2$ mm~~ $t = (0{,}01d_f + 2)\sqrt{k}$ mm
(2) Centreline girder	Web and face plate thickness Face plate width	~~$t = 0{,}01d_f + 2$~~ $t = (0{,}01d_f + 2)\sqrt{k}$ mm w = 140s mm
Longitudinal framing system		
(3) Centreline girder	Modulus Web thickness	$Z = 8{,}5 \times k \times D_{-1} \times S \times l_e^2$ cm^3
		~~$t = 0{,}01d_f + 2$ mm~~ $t = (0{,}01d_f + 2)\sqrt{k}$ mm
(4) Bottom transverses	Modulus	$Z = 7 \times k \times D_{-1} \times S \times l_e^2$ cm^3

	Web thickness	t = as centreline girder
Symbols		
B, D, T, S, s, l_e, Z and t are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* $D_{-1} = D$, but need not be taken greater than T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, T + 1,0 m for Zone 1 k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

(Part only shown)

Table 5.3.2 Double bottom construction forward and aft

Item	Parameter	Requirements
Transverse and longitudinal framing system		
(1) Centre girder	Thickness	~~$t = 0,01d_f + 1$ mm~~ $t = (0,01d_{\mathrm{f}} + 1)\sqrt{k}$ mm
Transverse framing system		
(5) Plate floors and brackets of bracket floors	Thickness	~~$t = 0,008d_f + 1$ mm~~ $t = (0,008d_{\mathrm{f}} + 1)\sqrt{k}$ mm
(6) Bottom frames in bracket floors	Modulus	$Z = 6 \times k \times s \times D_{-1} \times l_{e}^{2} + 1,5 + 0,05L$ cm^3
(7) Reverse frames in bracket floors	Modulus	$Z = 5,5 \times k \times s \times h \times l_{e}^{2} + 1,5 + 0,05L$ cm^3
Longitudinal framing system		
(8) Plate floors	Thickness	~~$t = 0,009d_f + 1$ mm~~ $t = (0,009d_{\mathrm{f}} + 1)\sqrt{k}$ mm
(9) Tank top longitudinal	Modulus	$Z = 5,5 \times k \times s \times h \times l_{e}^{2} + 1,5 + 0,05L$ cm^3
Symbols		
L, D, T, S, s, ~~t,~~ and Z are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* $D_{-1} = D$, but need not be taken greater than T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, T + 1,0 m for Zone 1 k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 4*

Shell envelope framing

4.2 Shell framing

(Part only shown)

Table 5.4.1 Shell frames and longitudinals forward and aft

Location	Modulus, in cm^3	Inertia, in cm^4
(1) Frames clear of tanks	~~$Z_1 = 1,2D_1 \times s\,(2,5H^2 + 0,03B^2 + 6)$~~ $Z_1 = 1,2D_1 \times k \times s\,(2,5H^2 + 0,03B^2 + 6)$	~~$I = 3,2H\,Z_1$~~ $I = \frac{3,2}{k} HZ_1$
(2) Frames in way of fuel oil or water tanks	The greater of the following: (a) $Z_{-2} = Z_{-1}$ (b) Z_{-2} = as required by *Pt 3, Ch 7 Bulkheads*	~~$I = 3,2H\,Z_2$~~ $I = \frac{3,2}{k} HZ_2$
(3) Bottom and side shell longitudinals clear of tanks	$Z_{-3} = 6 \times k \times s \times h_5 \times l_e^2 + 1,5 + 0,05L$	~~$I = 3,2l_eZ_3$~~ $I = \frac{3,2}{k} l_eZ_3$
(4) Bottom and side shell longitudinals in way of tanks	The greater of the following: (a) $Z_{-4} = Z_{-3}$ (b) Z_{-4} = as required by *Pt 3, Ch 7 Bulkheads*	~~$I = 3,2l_eZ_3$~~ $I = \frac{3,2}{k} l_eZ_4$
Symbols		
L, B, D, T, s, Z and I are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* $D_1 = D$, but need not be taken greater than T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, T + 1,0 m for Zone 1 k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

4.4 Web frames and side transverses

(Part only shown)

Table 5.4.2 Web frames, side transverses and stringers forward and aft

Location	Modulus, in cm^3	Inertia, in cm^4
(1) Web frames in a transverse framing system	$Z = 2,5 \times k \times (2 + n) \times s \times D_{-2}^{3}$	~~$I = 2,5D_2Z$~~ $I = \frac{2,5}{k} D_2Z$
(2) Side transverses in a longitudinal framing system	$Z = 7 \times k \times S \times D_{-2}^{3}$	~~$I = 2,5D_2Z$~~ $I = \frac{2,5}{k} D_2Z$
(3) Side stringers (fully effective)	$Z = 8 \times k \times S \times h \times l_e^2$	~~$I = 2,5\,l_eZ$~~ $I = \frac{2,5}{k} l_eZ$
Symbols		
D, T, S, s, Z and I are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* h_5 = distance, in metres, from mid-point of span to the deck at side or to a point T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, or T + 1,0 m for Zone 1 above the baseline, whichever is the lesser, with a minimum of 1 m k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 5*
Deck structure

5.2 Deck stiffening

(Part only shown)

Table 5.5.1 Deck beams and longitudinals forward and aft

Location	Modulus, in cm^3	Inertia, in cm^4
(1) Transverse beams	$Z = 4,3 \times k \times s \times h_1 \times l_e^2 + 1,5 + 0,05L$	-
(2) Longitudinals	$Z = 4,3 \times k \times s \times h_1 \times l_e^2 + 1,5 + 0,05L$	-
(3) In way of the crown of a tank	Z = as required in *Pt 3, Ch 7 Bulkheads*	~~$I = 2,3\ l_e$~~ $I = \frac{2,3}{k} l_e$
Symbols		
L, s, Z and I are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

5.3 Deck supporting structure

(Part only shown)

Table 5.5.2 Deck supporting structure fore and aft

Item	Parameter	Requirement
Girders and transverses in dry spaces, *see* Note	Modulus	$Z = 4,75 \times k \times h_1 \times S \times l_e^2$ cm^3
	Inertia	~~$I = 2,3 l_e Z$ cm^4~~ $I = \frac{2,3}{k} l_e Z$ cm^4
Pillars in dry spaces, *see* Note	Cross-sectional area of all types of pillar	~~$A_p = \frac{P}{1,26 - 4,2 \times \frac{l}{r}}$ cm^2~~ $A = \frac{k \times P}{1,26 - 4,2 \frac{l}{r\sqrt{k}}}$ cm^2
Symbols		
S, Z, I and t are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 6*
Fore peak structure

6.4 Wash bulkheads and perforated flats

(Part only shown)

Table 5.6.1 Fore peak structure

Item	Parameter	Requirement
(1) Collision bulkhead	Plating thickness	The greater of: ~~$t = 4 \times s \times \sqrt{h_5} + 1,5$ mm~~ $t = 4 \times s \times \sqrt{k h_5} + 1,5$ mm t = 5 mm t = 5,5 mm for water ballast tanks
	Stiffener modulus	$Z = 4,3 \times k \times s \times l_{e1}^2 \times h_{-5} + 4$ cm^3
(2) Perforated flats in void spaces	Plating thickness	The greater of: $t = 7s + 0,5$ mm t = 5 mm
	Stiffener modulus	$Z = 3,5 \times k \times s \times l_{e1}^2 + 3$ cm^3
(3) Wash bulkheads and perforated flats in tanks	Plating thickness	The greater of: $t = 7s + 1$ mm t = 5 mm
	Stiffener modulus	$Z = 3,5 \times k \times s \times l_{e1}^2 + 4$ cm^3
Symbols		
l_e, s, Z and t are as defined in *Pt 3, Ch 5, 1.4 Symbols and definitions 1.4.1* k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 8*
Sternframes and appendages

8.2 Sternframes

(Part only shown)

Table 5.8.1 Sternframes

Item	Parameter	Requirement
(3) Propeller shaft boss	t_b	~~$(0{,}25D_{ts} + t_2)\ \sqrt[3]{k_o}$ *mm*~~ $(0{,}25D_{ts} + t_2)\ \sqrt[3]{ek_o}$ mm

Part 3,
Chapter 6
Machinery Spaces

■ *Section 3*
Side shell structure

3.1 Primary structure

(Part only shown)

Table 6.3.1 Web frames and side transverses in machinery spaces

Location	Modulus, in cm^3	Inertia, in cm^4
(1) Web frames in a transverse framing system	$Z = 3{,}5 \times (1{,}5 + n) \times k \times s \times \boldsymbol{D}\text{-}\tfrac{2}{3}$	~~$I = 2{,}5D_{2}Z$~~ $\boldsymbol{I = \frac{2,5}{k} D_2 Z}$
(2) Side transverses in a longitudinal framing system	$Z = 8 \times k \times S \times D_{-2}^{3}$	~~$I = 2{,}5D_{2}Z$~~ $\boldsymbol{I = \frac{2,5}{k} D_2 Z}$
Symbols		
D, *S*, *s*~~,~~ and *Z* are as defined in *Pt 3, Ch 6, 1.3 Symbols and definitions 1.3.1* *k* = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 4*
Single and double bottom structure

4.2 Bottom construction

(Part only shown)

Table 6.4.1 Bottom construction in the machinery space

Item	Parameter	Scantlings
Transverse framing system		
Floors (single bottom)	Web depth at centreline Modulus Web thickness	$d_f = 50l_f$ mm $Z = 7{,}2 \times k \times D_{-1} \times s \times l_f^2$ cm^3
		~~$t = 0{,}01d_f + 2$ mm~~ $\boldsymbol{t = (0,01d_f + 2)\sqrt{k}}$ mm
Floors (double bottom)	Web thickness	~~$t = 0{,}008d_f + 2$ mm~~ $\boldsymbol{t = (0,008d_f + 2)\sqrt{k}}$ mm
Longitudinal framing system		
Bottom transverses	Modulus Web thickness	$Z = 10 \times k \times D_{-1} \times S \times l_e^2$ cm^3 ~~$t = 0{,}01d_f + 2$ mm~~ $\boldsymbol{t = (0,01d_f + 2)\sqrt{k}}$ mm
Floors (double bottom)	Web thickness	~~$t = 0{,}01d_f + 2$ mm~~ $\boldsymbol{t = (0,01d_f + 2)\sqrt{k}}$ mm
Transverse and longitudinal framing system		
Bottom shell plating in way of engine seating	Minimum thickness	~~$t = 0{,}03A + 4{,}5$ mm~~ $\boldsymbol{t = (0,03A + 4,5)\sqrt{k}}$ mm

Symbols
D, *T*, *S*, *s*~~,~~ and *Z* are as defined in *Pt 3, Ch 6, 1.3 Symbols and definitions 1.3.1* D_1 = *D*, but need not be taken greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1 *k* = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

Part 3,
Chapter 7
Bulkheads

■ *Section 1*
General

1.4 After peak bulkhead

1.4.1 All ships are to have an after peak bulkhead generally enclosing the sterntube and the rudder trunk in a watertight compartment. ~~This after peak bulkhead need not be fitted on the following ships if the sterntube is enclosed in a suitable watertight space:~~
~~(a) Ships with a length *L* less than 25 m.~~
~~(b) Ships where the forward machinery space bulkhead is situated less than seven per cent from the after perpendicular (A.P.).~~
~~(c) Ships where the forward machinery space bulkhead is situated less than 25 per cent from the after perpendicular and where the maximum allowable draught is less than 0,4*D*.~~
~~In ships with two or more propellers where the bossing ends forward of the after peak bulkhead, the sterntubes are to be enclosed in a suitable watertight space.~~
An after peak bulkhead generally enclosing the sterntube and the rudder trunk in a watertight compartment is to be arranged at a suitable distance from the stern at a location at which, when the watertight compartment aft of the aft peak bulkhead is fully flooded, the buoyancy of the fully loaded vessel is sufficient, with a residual safety distance of 100 mm from any opening which cannot be closed weathertight is attained. This after peak bulkhead need not be fitted on ships with a length *L* less than 25 m if the stern tube is enclosed in a suitable watertight space. In ships with two or more propellers where the bossing ends forward of the after peak bulkhead, the sterntubes are to be enclosed in a suitable watertight space.

1.4.2 As a general rule, the requirements of *Pt 3, Ch 7, 1.4 After peak bulkhead 1.4.1* shall be considered to have been met if the after peak bulkhead has been positioned at a distance between 0,04*L* and 0,04*L* + 2 m from the aft point of the intersection of the hull with the maximum draught line. If the distance exceeds 0,04*L* + 2 m, compliance with *Pt 3, Ch 7, 1.4 After peak bulkhead 1.4.1* shall be proven by direct calculations.

1.4.3 The distance from the aft point of the intersection of the hull with the maximum draught line may be reduced to 0,04*L* − 1 m, in which case the requirement of *Pt 3, Ch 7, 1.4 After peak bulkhead 1.4.1* shall be proven by direct calculations based on the flooding of both the compartment aft of the aft peak bulkhead and the immediately adjacent compartments.

■ *Section 2*
Scantlings of bulkheads

2.1 Watertight and deep tank bulkheads

(Part only shown)

Table 7.2.1 Watertight and deep tank bulkhead scantlings

Item and requirement	Watertight bulkheads	Deep tank bulkheads
(1) Plating thickness for plane and symmetrically corrugated bulkheads	The greater of the following: ~~$t = 4w\sqrt{h_4} + 0{,}5$ mm~~ $t = 4w\sqrt{h_4 k} + 0{,}5$ mm or *t* = 4 mm, *see* Note 3	The greater of the following: ~~$t = 4w\sqrt{\rho h_4} + a$ mm~~ $t = 4w\sqrt{\rho h_4 k} + a$ mm or *t* = 5 mm for oil tanks and fresh water tanks *t* = 5,5 mm for water ballast tanks, *see* Note 3
(2) Modulus of rolled and built stiffeners, swedges and symmetrical corrugations	$Z = 5 \times k \times s \times l_e^2 \times h_{-4}$ ~~3~~ cm^3	$Z = 6 \times k \times s \times l_e^2 \times h_{-4} \times \rho$ cm^3
(3) Stringers or webs supporting vertical or horizontal stiffening (a) Modulus	$Z = 7 \times k \times h_{-4} \times S \times l_e^2$ cm^3	$Z = 8{,}5 \times k \times h_{-4} \times S \times l_e^2 \times \rho$ cm^3

(b) Inertia		~~$I = 2,5 \times Z \times l_e$ cm^4~~ $I = \frac{2,5}{k} \times Z \times l_e$ cm^4
Symbols		
t = thickness of plating, in mm Z = section modulus of stiffening member, in cm^3, *see Pt 3, Ch 3, 3.2 Geometric properties of section* s = spacing of stiffeners, corrugations, girders or webs, in metres k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

2.2 Non-watertight bulkheads

(Part only shown)

Table 7.2.2 Non-watertight bulkheads

Parameter	Requirements
(1) Plating thickness for plane bulkheads	The greater of the following: ~~$t = 4 \times s \times \sqrt{h_4}$ mm~~ $t = 4 \times k \times s \times \sqrt{h_4}$ mm or t = 3,5 mm
(2) Modulus of rolled and built stiffeners and swedges	$Z = 4 \times k \times s \times l_e^2 \times h_4 + 3$ cm^3

(Part only shown)

Table 7.2.3 Bulkhead stiffeners supporting concentrated loads

Parameter	Requirements
(1) Cross-sectional area for rolled, built or swedged stiffeners, supporting girders, transverses, pillars or concentrated loads	~~$A = \frac{P}{1,26-4,2\frac{l}{r}}$ cm2~~ $A = \frac{k \times P}{1,26-4,2\frac{l}{r\sqrt{k}}}$ cm^2 *see* Note
Symbols	
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*	

Part 3,
Chapter 9
Special Features

■ *Section 2*
Decks loaded by wheeled vehicles

2.3 Deck plating

(Part only shown)

Table 9.2.1 Loading by wheeled vehicles

Item	Parameter	Requirements
(1) Deck plating	Plating thickness	~~$t = \alpha s + 1,5$ mm~~, $t = \frac{\alpha s}{\sqrt{k}} + 1,5$ mm *see* Note
(2) Deck beams, longitudinals and stiffeners when fork lift trucks are to be used	Section modulus	~~$Z = 0,375K_1Pl_e + 1,25K_2hsl_e^2$~~ $Z = (0,375K_1Pl_e + 1,25K_2hsl_e^2)k$ cm^3
(3) Deck beams, longitudinals and stiffeners for decks permanently used for vehicles, in association with a value of h which need not exceed 2,5 m	Section modulus	~~$Z = 0,536K_1Pl_e + 1,25K_2hsl_e^2$~~ $Z = (0,536K_1Pl_e + 1,25K_2hsl_e^2)k$ cm^3
(4) Deck girders and transverses	Section modulus	$Z = 4,75bhl_e^2k$ cm^3
Symbols		
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*		

■ *Section 4*
Lifting appliances and associated support arrangements

4.1 Lifting appliances and associated pedestals

4.1.1 It is the responsibility of the designer to ensure that the ship is suitable for the intended lifting appliance operations. Particular attention is drawn to ships or units which have heavy lift cranes (or lifting appliances) installed (*see Ch 4, 1.2 Lifting appliances and crane types 1.2.1 (k)* of the *Code for Lifting Appliances in a Marine Environment*).

Existing paragraphs 4.1.1 to 4.1.5 have been renumbered 4.1.2 to 4.1.6.

Part 3,
Chapter 10
Welding and Structural Details

■ *Section 2*
Welding

2.9 Slot welding

2.9.1 The slots are to have a minimum length of 75 mm and, in general, a minimum width of twice the side plating thickness or 20 mm, whichever is the greater. The ends of the slots are to be rounded. The space between the slots is not to exceed 150 mm.

■ *Section 3*
Secondary member end connections

3.5 Arrangements and details

(Part only shown)

Table 10.3.1 Bracket scantlings

Parameter	Requirement
Flange width	$t = 50\left(1 + \frac{Z}{1000}\right)$ mm

3.6 Bracketless connections

3.6.2 Type 2 connections may only be adopted at watertight ~~and hold~~ bulkhead stiffeners, wash bulkhead stiffeners and at stiffeners on centreline division bulkheads (non-tight) in tanks. Type 2 connections are not allowed for the secondary member end connections in way of the deep tank boundary or the shell boundary.

3.8 End connections of corrugated bulkheads

3.8.2 The yield stress of floors and/or carlings in line with the corrugated bulkhead is not to be less than the yield stress of the corrugated bulkhead.

Part 3
Chapter 12
Ship Control Systems

■ *Section 2*
Rudders

2.2 Rudder stock and bearings

(Part only shown)

Table 12.2.1 Rudder stock diameter

Item	Requirement
(1) Basic stock diameter, δ_S, at and below lowest bearing for mild steel	~~$\delta_S = 52{,}4K_R \sqrt[3]{K_0 f(V + 5{,}6)^2 \times \sqrt{A_R{}^2 x_p{}^2 + N^2}}$ mm~~ $\delta_S = 52{,}4K_R \sqrt[3]{f(V + 5{,}6)^2 \times \sqrt{A_R{}^2 x_p{}^2 + N^2}}$ mm
(2) Stock diameter, δ_{SO}, corrected for higher tensile steel	$\delta_{SO} = \delta_S \sqrt[3]{k_O}$ mm
~~(2)~~ (3) Diameter in way of tiller, δ_{SU}	$\delta_{SU} = \delta_{SO}$ in (2) with $N = 0$ For spade rudders: $\delta_{SU} \geq 0{,}7\delta_{SO}$
Symbols	
P_L = lateral force on rudder acting at centre of pressure of blade $= 117{,}5K_R f(V + 5{,}6)^2 A_R$	

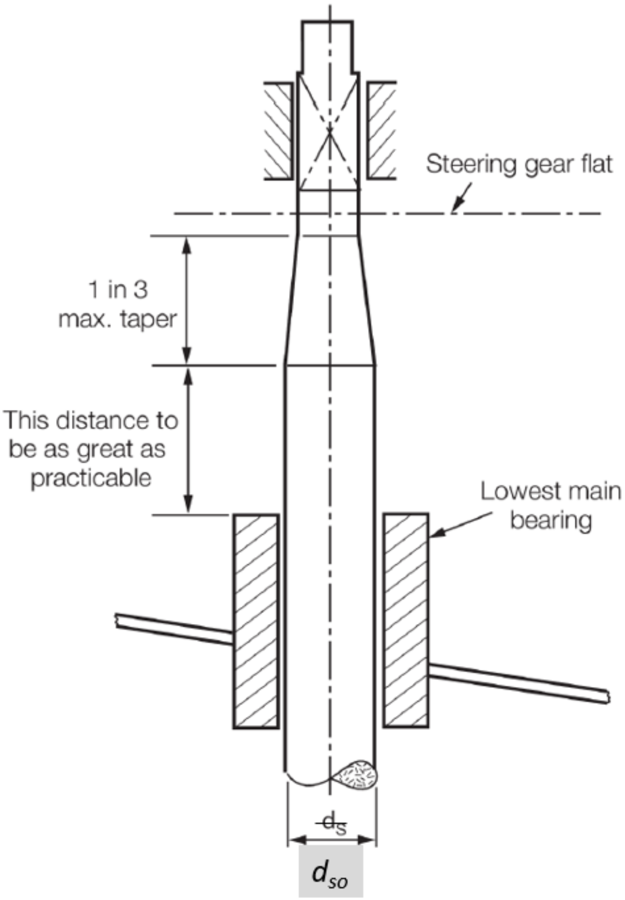

Figure 12.2.2 Taper of rudder stock

(Part only shown)

Table 12.2.6 Lowest main bearing requirements

Item	Requirements	
Lowest main bearing	Depth $z\text{-}_{B}$, in mm	
	$1{,}5\delta_{SO} \geq z\text{-}_{B} \geq 1{,}0\delta_{SO}$ For spade rudders: $1{,}5\delta_{SO} \geq z\text{-}_{B} \geq 1{,}3\delta_{SO}$	
Clearance in lowest main bearing on the diameter (note should be taken of the manufacturer's recommended clearances, particularly where bush material requires pre-soaking)	Bearing material	Clearance, in mm
	Metal (*see* note)	$0{,}001\delta_{SO} + 1{,}0$
	Synthetic	$0{,}002\delta_{SO} + 1{,}0$ but not less than 1,5
Symbols		
δ_{SO} = basic stock diameter, given by *Table 12.2.1 Rudder stock diameter*, in mm		

2.3 Rudder construction – Double~~d~~ plated

(Part only shown)

Table 12.2.7 Double plated rudder construction

Item	Requirements	
(1) Side plating	~~$t = 3y\text{ }_{W}\ (1{,}45 + 0{,}1\ \sqrt{\delta_S}) + 2$ mm~~	$t = 3y_{W}(1{,}45 + 0{,}1\sqrt{\delta_{SO}}) + 2$ mm
(5) Mainpiece - fabricated	Breadth and width $\geq \delta_{SO}$	
	$t\text{-}_{M} = 5 + 0{,}56\text{-}\sqrt{\delta_{SO}}$ mm	$t_{M} = 5 + 0{,}56\sqrt{\delta_{SO}}$ mm
(6) Mainpiece - tubular, *see* Note	Inside diameter $\geq \delta_{SO}$	
Symbols		
δ_{SO} = basic stock diameter, given by *Table 12.2.1 Rudder stock diameter*, in mm		

2.4 Rudder construction – Single plated

(Part only shown)

Table 12.2.8 Single plate rudder construction

Item and parameter	Requirements
Blade thickness	The greater of: $t = 5 + 0{,}02\delta_{SO} + 10y\text{-}_{W}$ mm $t = 10$ mm
Diameter of mainpiece	Diameter = δ_{SO} mm, *see* Note to *Table 12.2.7 Double plated rudder construction*
Symbols	
δ_{SO} = basic stock diameter, given by *Table 12.2.1 Rudder stock diameter*, in mm.	

2.5 Rudder couplings

(Part only shown)

Table 12.2.9 Rudder couplings to stock

Arrangement	Parameter	Requirements		
		Horizontal coupling		Vertical coupling
Bolted couplings	δ_b	~~$\frac{0{,}65\delta_S}{\sqrt{n}}$~~	$\frac{0{,}65\delta_S\sqrt{k_O}}{\sqrt{n}}$	~~$\frac{0{,}81\delta_S}{\sqrt{n}}$~~ $\frac{0{,}81\delta_S\sqrt{k_O}}{\sqrt{n}}$
	m	~~$0{,}00071n\delta_S\ \delta_b{}^2$~~	$0{,}00071n\delta_S\sqrt{k_O}\delta_b{}^2$	~~$0{,}00043\delta_S{}^3$~~ $0{,}00043\sqrt{k_O}\delta_S{}^3$
	α_{max} (*see* Note 2)	~~$(53{,}82 - 35{,}29k_1)\frac{\delta_S{}^3}{P_L h 10^3} - \left(1{,}8 - 6{,}3\frac{R}{\delta_S}\right)\frac{t_f - t_{fa}}{t_{fa}}$~~ $(53{,}82 - 35{,}29k_1)\frac{\delta_{SO}{}^3}{P_L h 10^3} - \left(1{,}8 - 6{,}3\frac{R}{\delta_{SO}}\right)\frac{t_f - t_{fa}}{t_{fa}}$		-
Symbols				
R = palm radius between rudder stock and connected flange, not smaller than $\frac{\cancel{\delta}\delta_{SO}}{10}$, in mm $\alpha_{as\ built}$ = stress concentration factor for as built scantlings $= \frac{0{,}73}{\sqrt{\frac{R}{\cancel{\delta}\delta_{SO}}}}$ δ_S, δ_{SO}, δ_{SU}, = rudder stock diameters as defined in *Table 12.2.1 Rudder stock diameter* ~~$P_L = 117{,}5k_R f(V + 5{,}6)2A_R$ [N]~~ P_L = lateral force on rudder acting at centre of pressure of blade, *see* *Table 12.2.1 Rudder stock diameter* k_R = ~~ruddercoefficient,*see*~~ rudder coefficient, *see* *Table 12.2.2 Rudder coefficient* ~~kR~~ *k_R* k_O = material factor as defined in *Table 12.2.1 Rudder stock diameter*, for the appropriate item				

M_T = maximum turning moment applied to stock, and is to be taken as the greater of:

(a) $\frac{11{,}1\delta_{SU}^{3}}{k_O}$ N mm

(b) The torque generated by the steering gear at the maximum working pressure (*see* *Pt 5, Ch 15, 1.2 Definitions 1.2.8*)

Note *1*. For spade rudders with horizontal coupling, t_f is not to be less than 0,25δ_{SO}.

■ *Section 5*
Equipment

5.1 Scope

5.1.4 The equipment of Inland Waterway vessels intended to navigate on the river Rhine and other European waterways must also comply with the ~~Rhine Inspection Regulations or The Directive of the European Parliament and of the Council of 12 December 2006, laying down technical requirements for Inland Waterway vessels~~ European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN), as applicable.

5.2 General

5.2.1 To entitle a ship to the figure **1** in its character of classification, the equipment is to be provided in accordance with this Section or in accordance with established National or International Regulations as agreed by the Committee, e.g. ~~the Rhine Inspection Regulations or The Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for Inland Waterway vessels~~ the European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN).

5.4 Bow anchors

~~5.4.3 The required mass calculated in accordance with *Pt 3, Ch 12, 5.4 Bow anchors 5.4.1* or *Pt 3, Ch 12, 5.4 Bow anchors 5.4.2*, as applicable, applies to ordinary stockless bower anchors. When anchors of a design approved for the designation 'High Holding Power' (HHP) are used, the mass of each such anchor may be reduced by the percentages given in *Table 12.5.2 High Holding Power Anchors*. HHP anchors not mentioned in *Table 12.5.2 High Holding Power Anchors* will be specially considered.~~

~~Table 12.5.2 High Holding Power Anchors~~

~~Type of anchor~~	~~Mass reduction %~~
~~HA – DU~~	~~30~~
~~D'Hone Special~~	~~30~~
~~Pool 1 (hollow)~~	~~35~~
~~Pool 2 (solid0~~	~~40~~
~~De Biesbosch – Danforth~~	~~50~~
~~Vicinay – Danforth~~	~~50~~
~~Vicinay AC 14~~	~~25~~
~~Vicinay Type 1~~	~~45~~
~~Vicinay Type 2~~	~~45~~
~~Vicinay Type 3~~	~~40~~
~~Stockes~~	~~35~~
~~D'Hone - Danforth~~	~~50~~
~~Schmitt high holding anchor~~	~~40~~

Existing paragraphs 5.4.4 and 5.4.5 have been renumbered as 5.4.3 and 5.4.4.

5.6 High holding power anchors

5.6.1 When high holding power anchors are used as bower anchors, the mass of each such anchor may be 75 per cent of the mass calculated for ordinary stockless bower anchors.

5.6.2 Anchor designs for which approval is sought as high holding power anchors are to be tested to show that they have holding powers of at least twice those of approved standard stockless anchors of the same mass. For holding power test requirements relating to high holding power anchors, *see* *Ch 10, 1.3 Anchor holding power tests for HHP and SHHP anchors* of the *Rules for the Manufacture, Testing and Certification of Materials*.

5.6.3 The anchor is to be suitable for the ship's use and is not to require prior adjustment or special placement on the riverbed.

5.6.4 High holding power anchors are to be of a design that will ensure that the anchors will take effective hold of the riverbed without undue delay and will remain stable, for holding forces up to those required by *Pt 3, Ch 12, 5.6 High holding power anchors 5.6.2*, irrespective of the angle or position at which they first settle on the river bed when dropped from a normal type of hawse pipe. In case of doubt, a demonstration of these abilities may be required.

5.7 Special anchors

5.7.1 For ships operating in European inland waterways, the required mass calculated in accordance with *Pt 3, Ch 12, 5.4 Bow anchors*, *Pt 3, Ch 12, 5.5 Stern anchors* or *Pt 3, Ch 12, 5.6 High holding power anchors*, as applicable, can be reduced by the percentages given in ESI-II-9 Section 1 of *European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN)* subject to agreement with the competent authority.

5.7.2 Special anchors are to be of an approved design and, in addition to the testing requirements given in *Ch 10 Equipment for Mooring and Anchoring* of the *Rules for the Manufacture, Testing and Certification of Materials*, are to be tested in accordance with the requirements of Article 13 of the *European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN)*.

~~5.6~~ 5.8 Number of anchors

~~5.6.2~~ 5.8.2 Where a vessel is equipped with only a single bow anchor and the hawse pipe is located ~~amidships~~ on the centreline, the mass P may be reduced by 15 per cent.

Existing sub-Sections 5.7 to 5.9 have been renumbered as 5.9 to 5.11.

~~5.9~~ 5.11 Chain cables

Existing paragraphs 5.9.1 to 5.9.3 have been renumbered 5.11.1 to 5.11.3.

~~5.9.4~~ 5.11.4 Chain cables may be either short link or stud link and of mild steel or special quality steel, in accordance with the requirements of ~~Chapter 10 of LR's *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials)~~ *Ch 10 Equipment for Mooring and Anchoring* of the *Rules for the Manufacture, Testing and Certification of Materials* and are to be graded in accordance with *Table 12.5.5 Chain cable steel grades*.

Existing paragraph 5.9.5 has been renumbered 5.11.5.

~~5.9.6~~ 5.11.6 Where wire rope is used in lieu of chain cable for anchoring, galvanised wire rope with an independent wire core in accordance with *Ch 10, 6 Steel wire ropes* of the ~~Rules for Materials~~ *Rules for the Manufacture, Testing and Certification of Materials* is to be used. Wire rope terminal fittings are to comply with an acceptable ~~code~~ Code or standard. The strength of terminations, connecting fittings, shackles or links is not to be less than that of the anchor line.

Existing paragraphs 5.9.7 has been renumbered 5.11.7.

~~5.9.8~~ 5.11.8 ~~The form and proportions of links and shackles are to be in accordance with Chapter 10 of LR's Rules for Materials and/or with International Standard ISO/R 1834–1971, ISO/R 1835–1971, ISO/R 1836–1971, ISO/1704–1973 :2008 or DIN 766A.~~
The form and proportions of links and shackles are to be in accordance with *Ch 10 Equipment for Mooring and Anchoring* or the *Rules for the Manufacture, Testing and Certification of Materials* and/or with the following International Standards;

- ISO 1834: *Short link chain for lifting purposes – General conditions of acceptance*;
- ISO 1835: *Round steel short link chains for lifting purposes – Medium tolerance sling chains – Grade 4, stainless steel*;
- ISO 1836: *Short link chain for lifting purposes – Grad M (4), calibrated, for chain hoists and other lifting appliances*;
- ISO 1704: *Ships and marine technology – Stud link anchor chains*, or
- DIN 766A.

Existing sub-Section 5.10 has been renumbered 5.12.

~~5.11~~ 5.13 Testing of equipment

~~5.11.1~~ 5.13.1 All anchors and chain cables are to be tested at establishments and on machines recognised by the Committee and under the supervision of LR's Surveyors or other Officers recognised by the Committee, and in accordance with *Ch 10 Equipment for Mooring and Anchoring* of ~~LR's Rules for Materials~~ the *Rules for the Manufacture, Testing and Certification of Materials*.

Existing paragraph 5.11.2 has been renumbered 5.13.2.

~~5.11.3~~ 5.13.3 For holding power testing requirements relating to High Holding Power anchors, *see* *Ch 10, 1.8 Super high holding power (SHHP) anchors* of the ~~Rules for Materials~~ *Rules for the Manufacture, Testing and Certification of Materials*. ~~As an alternative, Directive No. 7 to the Rhine Inspection Regulations may also be used.~~

5.13.4 For special anchors, proof tests are to be carried out in accordance with *Ch 10, 1.8 Super high holding power (SHHP) anchors* of the *Rules for the Manufacture, Testing and Certification of Materials* where the proof test load for the anchor is to be determined as follows;

$$\boldsymbol{Proof\ test\ load\ (special)} = \frac{\mathbf{25}}{\%\ \boldsymbol{mass\ reduction\ of\ special\ anchor}}\ \boldsymbol{x\ proof\ test\ kN}$$

See also Pt 3, Ch 12, 5.7 Special anchors 5.7.2.

~~5.11.4~~ 5.13.5 Steel wire and fibre ropes are to be tested as required by *Ch 10 Equipment for Mooring and Anchoring* of ~~LR's Rules for Materials~~ the *Rules for the Manufacture, Testing and Certification of Materials*.

~~5.11.5~~ 5.13.6 For ships certified in accordance with ~~the Rhine Inspection Regulations or The Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for Inland Waterway vessels~~ the European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN), a certificate in accordance with European ~~standard~~ Standard EN 10 204~~:1991~~ *Metallic Products* shall be kept on board for the required towlines and mooring lines.

Existing sub-Sections 5.12 and 5.13 have been renumbered 5.14. and 5.15.

Part 4,
Chapter 1
Dry Cargo Ships

■ *Section 1*
General

1.5 Symbols and definitions

(Part only shown)
1.5.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

L, *B*, *D*, *T* and C_{b} are as defined ~~in*Pt3,*~~ in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L is given in *Pt 3, Ch 2, Table 2.1.1 Values of* k_L
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 4*
Deck plating and continuous longitudinal hatch side coamings

4.1 General

4.1.2 For ships over ~~40~~ 65 m in length, the thickness of the deck and coaming plating may require to be increased to obtain the midship section modulus required in *Pt 3, Ch 4 Longitudinal Strength*.

■ *Section 5*
Hull envelope plating

5.1 General

5.1.1 This Section covers the requirements for the shell envelope plating, *viz.*~~,~~ keel, bottom, bilge and side shell plating. For deck plating, *see Pt 4, Ch 1, 4 Deck plating and continuous longitudinal hatch side coamings*. The thickness of shell envelope plating amidships is to be not less than required in *Table 1.5.1 Shell envelope plating*, but for ships over ~~40~~ 65 m in length, the thickness of the bottom plating may require to be increased to obtain the midship section modulus required in *Pt 3, Ch 4 Longitudinal Strength*.

5.3 Shell plating

(Part only shown)

Table 1.5.1 Shell envelope plating

Item and parameter	Requirement
6) Side shell plating	The greater of: ~~$t = (5{,}6 + 0{,}054L)\sqrt{s}$~~ $t = (5{,}6 + 0{,}054L)\sqrt{ks}$

Thickness	$t = 10s$
Symbols	
L, B, D, ~~s~~ s, k and t are as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*	

■ *Section 6*
Single bottom structure

6.1 General

(Part only shown)

Table 1.6.1 Transversely framed singled bottom

Item	Parameter	Requirements	
(1) Centreline girder	Web and face plate	~~$t = 0{,}008d_w + 3$ mm,~~ ~~see~~ *see* Note	$t = (0{,}008d_w + 3)\sqrt{k}$ mm
(3) Floors	Web thickness	~~$t_w = 0{,}008d_w + 3$ mm,~~ *see* Note	$t_w = (0{,}008d_w + 3)\sqrt{k}$ mm,
	Minimum required modulus	$Z = 6kT\text{-}s\text{-}B^2$ cm^3	
	Inertia	~~$I = 2{,}2 \times Zl$ cm^4~~	$I = \frac{2{,}2}{k} \times Zl$ cm^4
Symbols			
~~I~~ Z, B, T, s, k and t are as defined ~~in~~*~~Pt4,~~* in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*			

■ *Section 7*
Double bottom structure

7.1 General

(Part only shown)

Table 1.7.1 Double bottom structure

Item	Parameter	Requirement	
(2) Centreline girder and side girder	Thickness	~~$t = 0{,}008d_f + 3{,}0$ mm~~	$t = (0{,}008d_f + 3)\sqrt{k}$ mm
(3) Floors in a transverse framing system	Thickness Modulus	The greater of: ~~$t = 0{,}0085d_f + 2{,}0$ mm~~ $t = 7{,}0$ mm $Z = Ck\text{-}T\text{-}s\text{-}l_b^2$ cm^3	$t_w = (0{,}0085d_f + 2)\sqrt{k}$ mm
(4) Floors in a longitudinal framing system	Thickness Modulus	The greater of: ~~$t = 0{,}009d_f + 2{,}0$ mm~~ $t = 8{,}0$ mm $Z = Ck\text{-}T\text{-}s\text{-}l_b^2$ cm^3	$t_w = (0{,}009d_f + 2)\sqrt{k}$ mm
(5) Watertight floors	Thickness	The greater of: ~~$t = 0{,}0085d_f + 3{,}0$ mm~~ $t = 8{,}0$ mm	$t_w = (0{,}0085d_f + 3)\sqrt{k}$ mm
(7) Inner bottom longitudinals	~~Modules~~ Modulus	$Z = 4{,}85kH_{\text{-c}}\text{-}s\text{-}l_e^2$ cm^3	
(8) Bottom longitudinals	~~Modules~~ Modulus	$Z = (3{,}95 + 0{,}04L_{\text{-1}})\ D_{\text{-1}}ks\text{-}l_e^2$ cm^3	
Symbols			
L, B, D, T, S, s, t and Z are as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* $D_{\text{-1}} = D$, but need not be taken greater than $T + 0{,}4$ m for Zone 3, $T + 0{,}7$ m for Zone 2, $T + 1{,}0$ m for Zone 1			

■ *Section 8*

Additional requirements for double bottom structures in bulk carriers

8.1 General

(Part only shown)

Table 1.8.1 Requirements for double bottom structures in bulk carriers

Item	Parameter	Requirements
(1) Inner bottom plating	Thickness	The greater of: ~~$t = 4s\sqrt{p_{o}}$ mm~~ $t = 4s\sqrt{kp_{\mathrm{o}}}$ mm
		t = 8,0 mm This thickness is to be increased by 4 mm when no ceiling is fitted
(3) Inner bottom longitudinals	Section modulus	(1) Within 0,25*B* on either side of centreline: $Zl = 7,25P_{\mathrm{o}}k$~~s~~sl_{e}^{2} cm^3 (2) Outside 0,25*B* from centreline: The greater of: (a) $Z = 0,5Zl$ cm^3 (b) $Z = 4,85H$~~-~~$_{\mathrm{c}}$ k~~s~~sl_{e}^{2} cm^3
Symbols		
~~L, B, D, T, C_b, H_c, l_e, S, s, t and Z~~ *L*, *B*, *D*, *T*, C_{b}, H_{c}, l_{e}, *S*, *s*, *t*, *k* and *Z* are as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* and *Table 1.7.1 Double bottom structure*		

■ *Section 9*

Additional requirements for ~~containers~~ container ships

9.6 Stability

9.6.1 Attention is drawn to the intact stability requirements as contained in the ~~Rhine Inspection regulations and the Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for inland waterway vessels (2006/87/EC)~~ European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN).

■ *Section 10*

Single side shell and deck supporting structure

10.4 Brackets under deck

(Part only shown)

Table 1.10.1 Single skin construction

Item	Parameter	Requirement
(1) Frames	Modulus	~~$Z_f = 1,5k_1sT_1^{\ 3}\left(10 + 3\left(\frac{T_1}{H_1}\right) - \frac{10T_1}{H_1}\right) + Z_b$~~ $Z_{\mathrm{f}} = 1,5kk_1sT_1^{\ 3}\left(10 + 3\left(\frac{T_1}{H_1}\right)^2 - \frac{10T_1}{H_1}\right) + Z_{\mathrm{b}}$ cm^3
(2) Web frames	Modulus	~~$Z = 5,6S\frac{T_1^{\ 4}}{H_1^{\ 2}}(5H_1 - 2T_1) + Z_b$~~ $Z = 5,6kS\frac{T_1^{\ 4}}{H_1^{\ 2}}(5H_1 - 2T_1) + Z_{\mathrm{b}}$ cm^3
(3) Brackets under deck	Minimum required modulus	Z~~-~~$_{\mathrm{b}} = 29k \times k_2 \times b \times s(b \times h_1 + b_1 \times h_{\mathrm{h}})$ cm^3
Symbols		
≠ *D*, *T*, *S*, *s*, *t*, *k* and *Z* are as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* T~~-~~$_1 = D - q$ but need not be taken greater than $T + 0,4 - q$ for Zone 3, $T + 0,7 - q$ for Zone 2, $T + 1,0 - q$ for Zone 1, in metres		

■ *Section 11*

Double skin structure

11.2 Transverse framing

(Part only shown)

Table 1.11.1 Double skin structure (General requirements)

Item	Parameter	Requirement
(1) Shell frames	Modulus	~~$Z_f = 1{,}5 k_1 s T_1{}^3 \left(10 + 3\left(\frac{T_1}{H_1}\right)^2 - \frac{10T_1}{H_1}\right) + 2H_1 T_{SS}\sqrt{B}$~~ $Z_f = 1{,}5 k k_1 s T_1{}^3 \left(10 + 3\left(\frac{T_1}{H_1}\right)^2 - \frac{10T_1}{H_1}\right) + 2H_1 T_S\sqrt{B}$ cm^3
(4) Shell longitudinals	Modulus	$Z = (4,\text{-}6 + 0,\text{-}0342L_1) k h_s s l_e^2$ cm^3, *see* Note 1
(5) Horizontal stiffeners on longitudinal bulkhead	Modulus	~~$Z_l = 8Dsl_e^2$~~ $Z_l = 8kh_4sl_e^2$ cm^3, *see* Note 1
(6) Web frames at shell, *see* *Figure 1.11.3 Arrangement for web frames*	Modulus	$Z_w = 1{,}2 T_1{}^3 s \left(7 - \frac{4T_1}{H_1}\right)$ cm^3 $Z_w = 1{,}2 k T_1{}^3 s \left(7 - \frac{4T_1}{H_1}\right)$ cm^3
Symbols		
L, *B*, *D*, *T*, *S*, *s*, *t*, *k*, *Z* and *I* are as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*		
	$h_4 = h_o + 0{,}5\,b_1$ = the greater of the distance, in metres, from the middle of the effective length to the top of the cargo or = 1,5 m = whichever is the greatest h_o = the vertical distance, in metres, from the mid-point of span of the stiffener to the highest point of the tank including hatchway b_1 = the horizontal distance, in metres, from the centre line to the hatchway in way of the cargo hatch T_1 = D – q, but need be taken not greater than T + 0,4 – q for Zone 3, T + 0,7 – q m for Zone 2, T + 1,0 – q m for Zone 1, in metres	

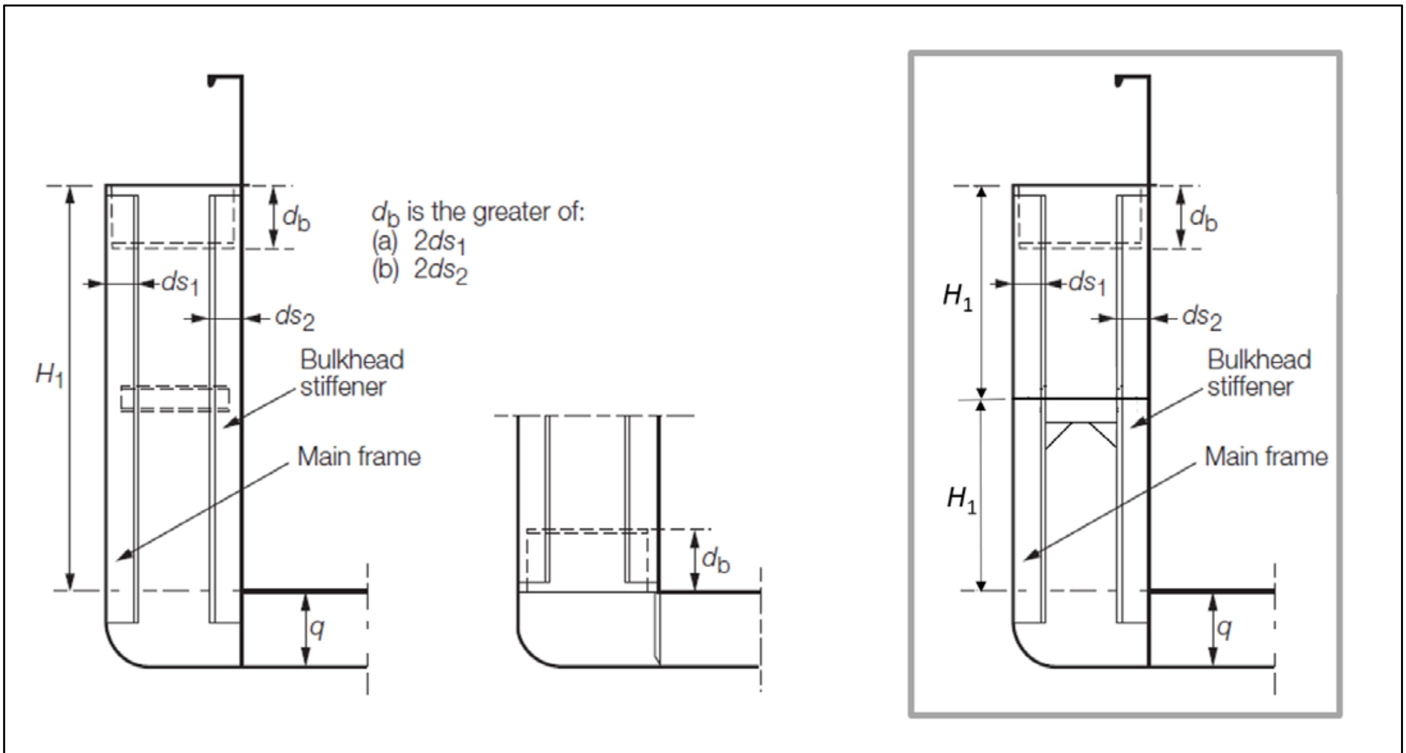

Figure 1.11.1 Frame arrangement (transverse framing)

11.5 Watertight sub-division

11.5.2 For ships navigating on the Rhine or on European waterways with an overall length greater than 110 m, compliance with damage stability requirements are mandatory in accordance with the ~~Rhine Inspection Regulations or with the Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for inland waterway vessels (2006/87/EC)~~ European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN).

■ *Section 13*
Direct calculation procedures

13.2 Permissible stresses

(Part only shown)

Table 1.13.1 Maximum permissible stress in longitudinal continuous ~~memebers~~ members, in N/mm²

Item	Local bending stress, σ_b	Combined bending stress, σ~~c~~$_c$, *see* Note 1	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e, *see* Note 2
Bottom girders	~~110~~ $0{,}46\sigma_L$	~~180~~ $0{,}75\sigma_L$	~~85~~ $0{,}35\sigma_L$	~~190~~ $0{,}80\sigma_L$
Bottom longitudinals, Inner bottom longitudinals, Side shell longitudinals	~~140~~ $0{,}58\sigma_L$	~~180~~ $0{,}75\sigma_L$	~~85~~ $0{,}35\sigma_L$	~~190~~ $0{,}80\sigma_L$
Where $\sigma_L=235/k_L$ Note *1* The combined stress, σ_c, is the sum of the stress due to longitudinal bending and local loading.				

(Part only shown)

Table 1.13.2 Maximum permissible stresses in local members, in N/mm²

Item	Bending stress, σ_b	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e, *see* Note
Floors, non-continuous bottom girders, non-continuous deck girders, deck transverses, cantilever brackets	~~130~~ $0{,}53\sigma_o$	~~85~~ $0{,}35\sigma_o$	~~180~~ $0{,}75\sigma_o$

Part 4,
Chapter 2
Ferries and Roll on-Roll off Ships

■ *Section 1*
General

1.1 Application

1.1.5 For ferries carrying passengers, the requirements of *Pt 4, Ch 9 Passenger Ships* are also to be complied with so far as applicable.

1.5 Symbols and definitions

(Part only shown)

1.5.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

L, B, D, T and C_b as defined in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L is given in *Pt 3, Ch 2, Table 2.1.1 Values of k_L*
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 3*
Topside structure and deck structure

3.1 General

3.1.2 Where a ship has a structural configuration according to *Figure 2.1.1 Configuration with single flush deck or a multi-deck hull with a single or double bottom arrangement and a single skin side construction*, the deck plating and deck supporting structure is to comply with the requirements of *Table 2.3.1 Deck plating and sheerstrake* and *Table 2.3.2 Deck supporting structure* respectively, but in ships over ~~40~~ 65 m in length, the thickness of deck plating may require to be increased to obtain the midship section modulus as required in *Pt 3, Ch 4 Longitudinal Strength*.

(Part only shown)

Table 2.3.1 Deck plating and sheerstrake

Item and Parameter	Longitudinal framing	Transverse framing
(1) Deck plating Thickness	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~ $t = (5{,}6 + 0{,}039L)\sqrt{ks}$ mm $t = 10s$ mm *See* Note 2 in *Table 2.3.2 Deck supporting structure*	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~ $t = (5{,}6 + 0{,}039L)\sqrt{ks}$ mm $t = 10s$ mm *See* Note 2 in *Table 2.3.2 Deck supporting structure*
	~~but for ships with a length, *L*, exceeding 40 m, t is to be not less than:~~	
	~~The greater of :~~ ~~$t = 0{,}076 \frac{M}{B \times D} - \frac{a_T}{10B}$ mm~~ ~~$t = 2{,}3 \sqrt[3]{\frac{MS \times s^2}{B \times D}}$ mm~~	~~The greater of :~~ ~~$t = 0{,}076 \frac{M}{B \times D}$ mm~~ ~~$t = 3{,}85 \sqrt[3]{\frac{MS \times s^2}{B \times D \times C_T}}$ mm~~

(Part only shown)

Table 2.3.2 Deck supporting structure

Item	Parameter	Requirements
(1) Deck beams	Modulus	$Z = 4{,}3 h_1 k s l_e^2 + 4$ cm^3
(2) Deck longitudinals	Modulus	$Z = (1{,}45 + 0{,}07L_1) h_1 k s l_e^2$ cm^3
(3) Deck girders	Modulus Inertia	$Z = (1{,}35 + 0{,}085L_1) h_1 k$ ~~s~~ $S l_e^2$ cm^3
		~~$I = 2{,}3 l_e Z$ cm^4~~ $I = \frac{2{,}3}{k} l_e Z$ cm^4
(4) Deck transverses	Modulus	$Z = 4{,}75 h_1 k$ ~~s~~ $S l_e^2$ cm^3
L, B, D, S, s, l_e, ~~Z, I~~ Z, I, k and t are as defined in *Pt 4, Ch 2, 1.5 Symbols and definitions 1.5.1*		

■ *Section 4*

Single bottom structure

4.1 General

(Part only shown)

Table 2.4.1 Longitudinally framed single bottom

Item	Parameter	Requirement
(1) Girders	Web and face plate thickness Width of face plate	~~$t = 0,01d_{\text{w}} + 3$ mm~~ $t = (0{,}01d_{\text{w}} + 3)\sqrt{k}$ mm $b_{\text{f}} = 100$ mm
(2) Bottom transverses	Modulus	$Z = 7D\text{-}_{1}k\text{-}S\text{-}l_{\text{e}}^{2}$ cm^{3}
(3) Bottom longitudinals	Modulus	$Z = (2 + 0{,}1L\text{-}_{1})\text{-}D\text{-}_{1}k\text{-}s\text{-}l_{\text{e}}^{2}$ cm^{3}
Symbols		
L, *B*, *D*, *T*, *S*, *s*, l_{e}, *Z*, *I*, *k* and *t* are as defined in *Pt 4, Ch 2, 1.5 Symbols and definitions 1.5.1*		

■ *Section 6*

Side shell structure

6.1 General

(Part only shown)

Table 2.6.1 Side shell structure (single skin ships)

Item	Parameter	Requirement
(1) Side frame	Modulus	$Z = 7h\text{-}_{\text{f}}k\text{-}s\text{-}l_{\text{e}}^{2}$ cm^{3}
(2) Side longitudinals	Modulus	$Z = (4{,}6 + 0{,}0342L\text{-}_{1})\text{-}h\text{-}_{\text{f}}k\text{-}s\text{-}l_{\text{e}}^{2}$ cm^{3}
(3) Side transverses	Modulus	$Z = 10h\text{-}_{\text{f}}k\text{-}S\text{-}l_{\text{e}}^{2}$ cm^{3} *See* Note
(4) Stringers	Modulus	$Z = 6{,}6h\text{-}_{\text{f}}k\text{-}S\text{-}l_{\text{e}}^{2}$ cm^{3}
(5) Webs supporting stringers and girders	Modulus	*Z* is to be determined from calculations using a stress of 98/*k* N/mm^{2} ~~(10,0 kgf/mm^{2})~~ assuming fixed ends, in association with a head, $h\text{-}_{\text{f}}$. *See* Note
Symbols		
L, *S*, *s*, l_{e}, *Z*, *k* and *I* are as defined in *Pt 4, Ch 2, 1.5 Symbols and definitions 1.5.1* $h\text{-}_{\text{f}}$ = the vertical distance, in metres, from the middle of the effective length of the stiffening member under consideration to the deck at side or to a line at *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1, whichever is the lesser, but is to be taken as not less than 2,0 m		

■ *Section 7*

Direct calculation procedures

7.1 General

(Part only shown)

Table 2.7.1 Maximum permissible stresses in longitudinal continuous members, in N/mm^{2} ~~(kgf/mm^{2})~~

Item	Local bending stress, σ_{b}	Combined bending stress, σ_{c}, *see* Note 1	Shear stress, ~~τ~~ τ	Equivalent stress, σ_{e}, *see* Note 2
Bottom girders Deck girders	~~108 (11,0)~~ $0{,}46\sigma_{\text{L}}$	~~177 (18,0)~~ $0{,}75\sigma_{\text{L}}$	~~83 (8,5)~~ $0{,}35\sigma_{\text{L}}$	~~188 (19,2)~~ $0{,}80\sigma_{\text{L}}$
Bottom longitudinals Inner bottom longitudinals Deck longitudinals Side shell longitudinals	~~137 (14,0)~~ $0{,}58\sigma_{\text{L}}$	~~177 (18,0)~~ $0{,}75\sigma_{\text{L}}$	~~83 (8,5)~~ $0{,}35\sigma_{\text{L}}$	~~188 (19,2)~~ $0{,}80\sigma_{\text{L}}$
Where $\sigma_{\text{L}} = 235/k_{\text{L}}$ Note *1* The combined stress, σ_{c}, is the sum of the stress due to longitudinal bending and local loading.				

(Part only shown)

Table 2.7.2 Maximum permissible stresses in local members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Bending stress, σ_b	Shear ~~stress,τ~~ stress, τ	Equivalent stress, σ_e, *see* Note
Floors, non-continuous bottom girders, non-continuous deck girders, deck transverses~~,~~	~~124 (12,6)~~ 0,53σ_o	~~83 (8,5)~~ 0,35σ_o	~~177 (18,0)~~ 0,75σ_o
Web frames	~~98 (10,0)~~ 0,42σ_o	~~83 (8,5)~~ 0,35σ_o	~~163 (16,6)~~ 0,69σ_o
Frames, bottom transverse	~~113 (11,5)~~ 0,48σ_o	~~83 (8,5)~~ 0,35σ_o	~~172 (17,5)~~ 0,73σ_o
Deck beams	~~137 (14,0)~~ 0,58σ_o	~~83 (8,5)~~ 0,35σ_o	~~186 (19,0)~~ 0,79σ_o

Part 4,
Chapter 3
Pontoons

■ *Section 1*
General

1.5 Symbols and definitions

(Part only shown)

1.5.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

L, *B*, *D* and *T* ≠ are as defined in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L is given in *Pt 3, Ch 2, Table 2.1.1 Values of* k_L
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 3*
Hull envelope plating

3.1 General

3.1.1 The requirements of *Pt 4, Ch 1, 5 Hull envelope plating* are to be applied together with the requirements of this Section. The thickness of hull envelope plating amidships is to be not less than required in *Table 3.3.1 Hull envelope plating*, but for ships over ~~40~~ 65 m in length, the thickness of the bottom plating and deck plating may require to be increased to obtain the midship section modulus required in *Pt 3, Ch 4 Longitudinal Strength*.

(Part only shown)

Table 3.3.1 Hull envelope plating

Item and parameter	Required minimum scantlings	
(2) Bottom plating Thickness	Longitudinal framing	Transverse framing
	The greater of : ~~$t_b = (5{,}6 + 0{,}054L)\sqrt{s}$ mm~~ $t_\mathrm{b} = (5{,}6 + 0{,}054L)\sqrt{ks}$ mm ~~t_b~~ t_b = 10*s* mm	The greater of : $t_b = (5{,}6 + 0{,}054L)\sqrt{s}$ mm $t_\mathrm{b} = (5{,}6 + 0{,}054L)\sqrt{ks}$ mm ~~t_b~~ t_b = 10*s* mm
(5) Side shell plating Thickness	~~The greater of :~~ ~~$t_b = (5{,}6 + 0{,}054L)\sqrt{s}$ mm~~ ~~$t_b = (5{,}6 + 0{,}054L)\sqrt{s}$ mm~~ $t_\mathrm{b} = (5{,}6 + 0{,}054L)\sqrt{ks}$ mm ~~t_b~~ t_b = 10*s* mm	
(7) Deck Plating thickness	Longitudinal framing	Transverse framing
	The greater of~~-~~: ~~$t_b = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~	The greater of~~-~~: ~~$t_b = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~

	$t_b = (5,6 + 0,039L)\sqrt{ks}$ mm ~~t_b~~ t_b = 10s mm t = 6 mm *See* note 2	$t_b = (5,6 + 0,039L)\sqrt{ks}$ mm ~~t_b~~ t_b = 10s mm t = 6 mm *See* note 2
	~~but for ships with a length, L, exceeding 40 m, t is to be not less than:~~	
	~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B\times D} - \frac{a_T}{10B}$ mm~~ ~~$t = 2{,}3\sqrt[3]{\frac{MS\times s^2}{B\times D}}$ mm~~	~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B\times D}$ mm~~ ~~$t = 3{,}85\sqrt[3]{\frac{MS\times s^2}{B\times D\times C_T}}$ mm~~
Symbols		
L, *B*, *D*, *T*, *S*, *s*, *k* and *t* are as defined in *Pt 4, Ch 3, 1.5 Symbols and definitions 1.5.1*		

■ *Section 4*
Hull envelope framing (longitudinal or transverse framing)

4.1 General

(Part only shown)

Table 3.4.1 Hull envelope framing

Item	Parameter	Requirements
(1) Floors	Modulus Web depth Web thickness	$Z = 6{,}6 \times k \times D_{-1} \times s \times l_e^2$ cm³ $d_w \geq 30B$ mm ~~$t = 0{,}01 d_w + 2$ mm~~ $t = (0{,}01 d_w + 2)\sqrt{k}$ mm
(2) Bottom longitudinals	Modulus Inertia	$Z = (2 + 0{,}1L_{-1}) \times D_{-1} \times k \times s \times l_e^2$ cm³ ~~$I = 2{,}3 \times l_e \times Z$ mm~~ $I = \frac{2{,}3}{k} \times l_e \times Z$ cm⁴
(3) Bottom transverses	Modulus	$Z = 7 \times D_{-1} \times k \times S \times l_e^2$ cm³
(4) Bottom centre girder	Web and face plate thickness Minimum flange width	~~$t = 0{,}01 d_w + 3$ mm~~ $t = (0{,}01 d_w + 3)\sqrt{k}$ mm b_{-f} = 100 mm
(6) Side frames	Modulus	$Z = 7 \times h_{-f} \times k \times s \times l_e^2$ cm³ *See* Note 1
(7) Side longitudinals	Modulus	$Z = (4{,}6 + 0{,}0342L_{-1}) \times h_{-f} \times k \times s \times l_e^2$ cm³
(8) Side transverses	Modulus	$Z = 10 \times h_{-f} \times k \times S \times l_e^2$ cm³ *See* Note 1
(9) Stringers	Modulus	$Z = 6{,}6 \times h_{-f} \times k \times S \times l_e^2$ cm³
(10) Web supporting stringers and girders	Modulus	*Z* is to be determined from calculations using a stress of 98/*k* N/mm² ~~(10,0 kgf/mm²)~~, assuming fixed ends, in association with a head, h_{-f} *See* Note 1
(11) Deck beams	Modulus	$Z = 4{,}3 \times h_{-1} \times k \times s \times l_e^2 + 4$ cm³
(12) Deck longitudinals	Modulus Inertia	$Z = (1{,}45 + 0{,}07L_{-1}) \times h_{-1} \times k \times s \times l_e^2$ cm³ ~~$I = 2{,}3 \times l_e \times Z$ cm⁴~~ $I = \frac{2{,}3}{k} \times l_e \times Z$ cm⁴
(13) Deck girders	Modulus Inertia	$Z = (1{,}35 + 0{,}085L_{-1}) \times k \times S \times h_{-1} \times l_e^2$ cm³ ~~$I = 2{,}3 \times l_e \times Z$ cm⁴~~ $I = \frac{2{,}3}{k} \times l_e \times Z$ cm⁴
(14) Deck transverses	Modulus	$Z = 4{,}75 \times h_{-1} \times k \times S \times l_e^2$ cm³
Symbol		
L, *B*, *D*, *T*, *S*, *s*, l_e, *Z*, *I*, *k* and *t* are as defined in *Pt 4, Ch 3, 1.5 Symbols and definitions 1.5.1* D_{-1} = *D*, but need not be taken greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1		

■ *Section 5*
Direct calculation procedures

5.2 Permissible stresses

(Part only shown)

Table 3.5.1 Maximum permissible stresses in longitudinal continuous members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Local bending stress, σ_b	Combined bending stress, σ_c, *see* Note 1	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e, *see* Note 2
Bottom girders Deck girders	~~108 (11,0)~~ 0,46σ_L	~~177 (18,0)~~ 0,75σ_L	~~83 (8,5)~~ 0,35σ_L	~~188 (19,2)~~ 0,80σ_L
Bottom longitudinals Inner bottom longitudinals Deck ~~L~~longitudinals Side shell longitudinals	~~137 (14,0)~~ 0,58σ_L	~~177 (18,0)~~ 0,75σ_L	~~83 (8,5)~~ 0,35σ_L	~~188 (19,2)~~ 0,80σ_L
Where $\sigma_L = 235/k_L$ Note *1* The combined stress, σ_c, is the sum of the stress due to longitudinal bending and local loading.				

(Part only shown)

Table 3.5.2 Maximum permissible stresses in local members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Bending stress, σ_b	Shear stress, τ	Equivalent stress, σ_e, *see* Note
Floors, non-continuous bottom girders, non-continuous deck girders, deck transverses	~~124 (12,6)~~ 0,53σ_o	~~83 (8,5)~~ 0,35σ_o	~~177 (18,0)~~ 0,75σ_o
Web frames	~~98 (10,0)~~ 0,42σ_o	~~83 (8,5)~~ 0,35σ_o	~~163 (16,6)~~ 0,69σ_o
Frames, bottom transverses	~~113 (11,5)~~ 0,48σ_o	~~83 (8,5)~~ 0,35σ_o	~~172 (17,5)~~ 0,73σ_o
Deck beams	~~137 (14,0)~~ 0,58σ_o	~~83 (8,5)~~ 0,35σ_o	~~186 (19,0)~~ 0,79σ_o

Part 4,
Chapter 4
General Requirements For Tankers Carrying Dangerous Liquids in Bulk

■ *Section 1*
General

1.1 Application and definitions

(Part only shown)

1.1.10 **Classification of zones** (*see* IEC publication 79-10, ~~EU directive 1999/92/EG~~ the European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN)):

Part 4,
Chapter 5
Tankers of Type G

■ *Section 1*
General

1.10 Symbols and definitions

(Part only shown)

1.10.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

~~*L*, *B*, *D* and = are as defined in *Pt 3, Ch 1, 6.1 Principal particulars*~~
~~*T*~~
L, *B*, *D* and C_b are as defined in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L is given in *Pt 3, Ch 2, Table 2.1.1 Values of* k_L
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 6*
Single bottom structure in way of cargo compartment space

6.1 General

(Part only shown)

Table 5.6.1 Single bottom structure in way of cargo compartment space

Item	Parameter	Requirements	
Transverse framing system			
(1) Centreline girder, side girders and partial side girders	Web and face plate thickness	~~$t = 0{,}01d_w + 2{,}5$ mm~~	$t = (0{,}01d_w + 2{,}5)\sqrt{k}$ mm
(2) Floors	Web thickness	~~$t_w = 0{,}01d_w + 2{,}5$ mm~~	$t_w = (0{,}01d_w + 2{,}5)\sqrt{k}$ mm
	Minimum modulus	~~$Z = 7Tsl_f^2$ cm^3~~	$Z = 7kTsl_f^2$ cm^3
(3) Bottom structure supporting cargo tanks (combination of floors with top and bottom plating)	Minimum modulus	~~$Z = 8{,}5l_f(W - 0{,}3l_f^2 T)$ cm^3~~	$Z = 8{,}5kl_f(W - 0{,}3l_f^2\text{-}T)$ cm^3
Longitudinal framing system			
(4) Centreline girder, side girders and partial side girders	Web and face plate thickness	~~$t = 0{,}01d_w + 3$ mm~~	$t = (0{,}01d_w + 3)\sqrt{k}$ mm
(5) Transverses	Web thickness	~~$t = 0{,}01d_w + 3$ mm~~	$t = (0{,}01d_w + 3)\sqrt{k}$ mm
	Modulus	~~$Z = 7TSl_f^2$ cm^3~~	$Z = 7kTSl_f^2$ cm^3
(6) Bottom structure supporting cargo tanks (combination of floors/ transverses with top and bottom plating)	Minimum modulus	~~$Z = 8{,}5l_f(W - 0{,}3l_f^2 T)$ cm^3~~	$Z = 8{,}5kl_f(W - 0{,}3l_f^2\text{-}T)$ cm^3
(7) Bottom longitudinals	Modulus	~~$Z = (3{,}95 + 0{,}04L_1)D_1 sl_e^2$ cm^3~~	$Z = (3{,}95 + 0{,}04L_{-1})kD\text{-}_1\text{-}sl_e^2$ cm^3
L, *B*, *D*, *T*, *S*, *s*, l_e, *k*, ~~*Z*~~*Z* and *t* are as defined in *Pt 4, Ch 5, 1.10 Symbols and definitions 1.10.1* $D_{-1} = D$, but need not be taken greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1			

■ *Section 7*
Double bottom structure in way of cargo compartment space

7.1 General

(Part only shown)

Table 5.7.1 Double bottom structure in way of cargo compartment space

Item	Parameter	Requirements	
Longitudinal and transverse framing system			
(1) Centreline girder, side girders and partial side girders	Thickness	~~$t = 0{,}01d_f + 2{,}5$ mm~~	$t = (0{,}01d_{\mathrm{f}} + 2{,}5)\sqrt{k}$ mm
Transverse framing system			
(4) Floors	Thickness	~~$t = 0{,}007d_f + 3,$ mm~~	$t = (0{,}007d_{\mathrm{f}} + 3{,}0)\sqrt{k}$ mm
(5) Watertight floors	Thickness	~~$t = 0{,}007d_f + 3{,}5$ mm~~	$t = (0{,}007d_{\mathrm{f}} + 3{,}5)\sqrt{k}$ mm
(6) Combination of floors in conjunction with bottom and inner bottom plating	Modulus	~~$Z = 8{,}5l_{\mathrm{f}}(W - 0{,}45l_{\mathrm{f}}^2 T)$ cm^3~~	$Z = 8{,}5kl_{\mathrm{f}}(W - 0{,}45l_{\mathrm{f}}^2\text{-}T)$ cm^3
(7) Floors and watertight floors	Thickness	~~$t = 0{,}0085d_f + 3{,}5$ mm~~	$t = (0{,}0085d_{\mathrm{f}} + 3{,}5)\sqrt{k}$ mm
(8) Combination of floors in conjunction with bottom and inner bottom plating	Modulus	~~$Z = 8{,}5l_{\mathrm{f}}(W - 0{,}45l_{\mathrm{f}}^2 T)$ cm^3~~	$Z = 8{,}5kl_{\mathrm{f}}(W - 0{,}45l_{\mathrm{f}}^2\text{-}T)$ cm^3
(9) Bottom longitudinals	Modulus	~~$Z = (3{,}95 + 0{,}04L_{-1})D_{-1}\, sl_{\mathrm{e}}^2$ cm^3~~	$Z = (3{,}95 + 0{,}04L\text{-}_1)D\text{-}_1k\text{-}sl_{\mathrm{e}}^2$ cm^3
(10) Inner bottom longitudinals	Modulus	~~$Z = 6{,}75\left(T - \frac{d_{\mathrm{f}}}{1000}\right)sl_e^2$ cm^3~~	$Z = 6{,}75\left(T - \frac{d_{\mathrm{f}}}{1000}\right)ksl_e^2$ cm^3
Symbols			
L, *B*, *D*, *T*, *s*, *l*e, *k*, *Z* and *t* are as defined in *Pt 4, Ch 5, 1.10 Symbols and definitions 1.10.1* *D*-1 = *D*, but need not be taken greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1			

■ *Section 8*
Side shell framing in way of cargo compartment space

8.2 Transverse framing

(Part only shown)

Table 5.8.1 Side shell framing

Item	Parameter	Requirements	
Transverse framing			
Side frames Side frames of combination	Modulus	~~$Z = 7s\, l_{\mathrm{e}}^2\, h_{\mathrm{f}}$ cm^3~~ ~~$Z = 7s\, l_{\mathrm{e}}^2\, h_{\mathrm{f}}$ cm^3~~	$Z = 7ks\text{-}l_{\mathrm{e}}^2\text{-}h_{\text{-f}}$ cm^3 $Z = 7ks\, l_{\mathrm{e}}^2\text{-}h\text{-}_{\mathrm{f}}$ cm^3
Longitudinal framing			
Side shell longitudinals	Modulus	~~$Z = (4{,}6 + 0{,}0342L_{-1})\, sl_{\mathrm{e}}^2 h_{\mathrm{f}}$ cm^3~~	$Z = (4{,}6 + 0{,}0342L\text{-}_1)\text{-}ksl_{\mathrm{e}}^2h_{\text{-f}}$ cm^3
Side transverses	Modulus	~~$Z = 10Sl_{\mathrm{e}}^2\, h_{\mathrm{f}}$ cm^3~~	$Z = 10kSl_{\mathrm{e}}^2\text{-}h_{\text{-f}}$ cm^3
Transversely and longitudinally framed ships			
Web frames in way of floors/transverses of bottom structure supporting the cargo tanks	Modulus	~~$Z = 40Sl_{\mathrm{e}}^2$ cm^3~~	$Z = 40kSl_{\mathrm{e}}^2$ cm^3
Symbols			
L, *D*, *T*, *S*, *s*, *l*e, *k* and *Z* are as defined in *Pt 4, Ch 5, 1.10 Symbols and definitions 1.10.1*			

■ *Section 10*
Deck support structure

10.1 General

(Part only shown)

Table 5.10.1 Deck support structure

Item	Parameter	Requirements	
Transverse framing			
Deck beams in flush deck ships Trunk deck beams	Modulus	~~$Z_{\mathrm{b}} = 3{,}1s\, l_{\mathrm{e}}^2$ cm^3~~	$Z\text{-}_{\mathrm{b}} = 3{,}1ks\text{-}l_{\mathrm{e}}^2$ cm^3

Deck girders	Modulus	~~$Z = (0{,}33 + 0{,}062L_1)\, S\, l_e^2$ cm^3~~	$Z = (0{,}33 + 0{,}062L_1)k\text{-}S\text{-}l_e^2$ cm^3
Longitudinal framing			
Deck longitudinals in flush deck ships Trunk deck longitudinals Trunk side longitudinals Deck longitudinals abreast trunks	Modulus Inertia	~~$Z = (0{,}073L_1 - 0{,}5)\, s\, l_e^2$ cm^3~~ ~~$I = 2{,}3\, l_e^2\, Z$ cm^4~~	$Z = (0{,}073L_1 - 0{,}5)k\text{-}s\text{-}l_e^2$ cm^3 $I = \frac{2{,}3}{k}\, l_e^2 Z$ cm^4
Deck transverses in flush deck ships Trunk deck transverses	Modulus	~~$Z_t = 3{,}1S\, l_e^2$ cm^3~~	$Z_t = 3{,}1kS\text{-}l_e^2$ cm^3
Symbols			
L, *S*, *s*, l_e, *Z*, *k* and *I* are as defined in *Pt 4, Ch 5, 1.10 Symbols and definitions 1.10.1*			

■ *Section 11*
Direct calculation procedures

11.2 Permissible stresses

(Part only shown)

Table 5.11.1 Maximum permissible stresses in longitudinal continuous members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Local bending stress, σ_b, ~~See~~ *see* Note 1	Combined bending stress, ~~σ_b~~ σ_c, *see* Note 1	Shear stress ~~τ~~ τ	Equivalent stress, σ_e, ~~See~~ *see* Note 2
Bottom girders Deck girders	~~108 (11,0)~~ 0,46σ_L	~~177 (18,0)~~ 0,75σ_L	~~83 (8,5)~~ 0,35σ_L	~~188 (19,2)~~ 0,80σ_L
Bottom longitudinals Inner bottom longitudinals Deck and trunk deck longitudinals Side shell longitudinals	~~137 (14,0)~~ 0,58σ_L	~~177 (18,0)~~ 0,75σ_L	~~83 (8,5)~~ 0,35σ_L	~~188 (19,2)~~ 0,80σ_L
Where $\sigma_L = 235/k_L$ Note *1* The combined stress, σ_c, is the sum of the stress due to longitudinal bending and local loading.				

(Part only shown)

Table 5.11.2 Maximum permissible stresses in local members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Local bending stress, σ_b	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e, ~~See~~ *see* Note
Non-continuous bottom girders, side stringers, *see* Note 2, deck beams, deck transverses and non-continuous deck girders	~~124 (12,6)~~ 0,53σ_o	~~83 (8,5)~~ 0,35σ_o	~~177 (18,0)~~ 0,75σ_o
Floors, bottom transverses and bottom structure supporting tanks	~~116 (11,8)~~ 0,50σ_o	~~83 (8,5)~~ 0,35σ_o	~~172 (17,5)~~ 0,73σ_o
Side frames	~~113 (11,5)~~ 0,48σ_o	~~83 (8,5)~~ 0,35σ_o	~~172 (17,5)~~ 0,73σ_o
Webs supporting side stringers and side transverses, *see* Note 2	~~103 (10,5)~~ 0,44σ_o	~~83 (8,5)~~ 0,35σ_o	~~167 (17,0)~~ 0,71σ_o

Part 4,
Chapter 6
Tankers of Types C and N

■ *Section 1*
General

1.12 Symbols and definitions

(Part only shown)
1.12.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

~~*L*, *B*, *D*, *T* = are as defined in *Pt 3, Ch 1, 6.1 Principal particulars*~~
L, *B*, *D*, *T* and C_b are as defined in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L is given in *Pt 3, Ch 2, Table 2.1.1 Values of k_L*
k = higher tensile steel factor, *see Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 3*
Hull envelope framing

3.1 General

3.1.2 The thickness of the hull envelope plating amidships is to be not less than required in this Section, but in ships over ~~40~~ 65 m in length, the thickness of bottom plating and top side plating (and/or longitudinal stiffening members) may require to be increased to obtain the midship section modulus as required in *Pt 3, Ch 4 Longitudinal Strength*.

3.2 Keel

(Part only shown)
Table 6.3.1 Hull envelope plating and inner bottom plating - All tankers

Item and Parameter	Required minimum scantlings, *see* Note 1	
(2) Bottom plating Thickness *See* note 2	Longitudinal framing	Transverse framing
	The greater of: ~~$t_b = (5,6 + 0,054L)\sqrt{s}$ *mm*~~ $t_{\mathrm{b}} = (5,6 + 0,054L)\sqrt{ks}$ mm ~~t_b~~ t_{b} = 10*s* ~~*mm*~~ mm	The greater of: ~~$t_b = (5,6 + 0,054L)\sqrt{s}$ *mm*~~ $t_{\mathrm{b}} = (5,6 + 0,054L)\sqrt{ks}$ mm ~~t_b~~ t_{b} = 10*s* ~~*mm*~~ mm
	~~but for ships with a length, *L*, exceeding 40 m, t_b is to be not less than:~~	
	~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B \times D_1} - \frac{a_1}{10B}$ mm~~ ~~$t = 2{,}3\sqrt[3]{\frac{MH \times s^2}{B \times D_1}}$ mm~~	~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B \times D_1} - \frac{a_1}{10B}$ mm~~ ~~$t = 2{,}85\sqrt[3]{\frac{MH \times s^2}{B \times D_1 \times C_1}}$ mm~~
(8) Inner bottom plating	The greater of: *t* = 12~~s~~*s* mm $t = 4s\sqrt{kh_s} + K_C$ ~~*mm*~~ mm	
Symbols		
L, *B*, *D*, *T*, *S*, *s*,~~and*t*~~ *k* and *t* are as defined in *Pt 4, Ch 6, 1.12 Symbols and definitions 1.12.1* ~~a_1 = total area of deck longitudinals, in cm^2~~ ~~$C_1 = 1 + 3\left(\frac{s}{S}\right)^2$, where s/S is the ratio of the unstiffened bottom panel under consideration~~ ~~*M* = the greater of M_S and M_H~~ ~~*MH* = maximum design hogging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~ ~~*MS* = maximum design sagging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~		

3.6 Deck plating of transversely framed flush deck tankers

(Part only shown)

Table 6.3.2 Hull envelope plating - Flush deck tankers deck plating

Item and parameter	Longitudinal framing		Transverse framing	
Deck plating: Thickness *See* Note	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~ t = 10s mm	$t = (5{,}6 + 0{,}039L)\sqrt{ks}$ mm	The greater of: ~~$t = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~ t = 10s mm	$t = (5{,}6 + 0{,}039L)\sqrt{ks}$ mm
	~~but for ships with a length, *L*, exceeding 40 m, *t* is to be not less than:~~			
	~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B\times D} - \frac{a_1}{10B}$ mm~~ ~~$t = 2{,}3\sqrt[3]{\frac{MS\times s^2}{B\times D}}$ mm~~		~~The greater of :~~ ~~$t = 0{,}076\frac{M}{B\times D}$ mm~~ ~~$t = 2{,}3\sqrt[3]{\frac{MS\times s^2}{B\times D\times C_1}}$ mm~~	
Symbols				
L, *B*, *D*, *S*, *s*, *k* and *t* are as defined in *Pt 4, Ch 6, 1.12 Symbols and definitions 1.12.1* ~~a_1 = total area of deck longitudinals, in cm^2~~ ~~$C_1 = 1 + 3\left(\frac{s}{S}\right)^2$, where s/S is the ratio of the unstiffened bottom panel under consideration~~ ~~*M* = the greater of M_S and M_H~~ ~~*MH* = maximum design hogging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~ ~~*MS* = maximum design sagging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~				

3.7 Trunk deck plating, trunk side plating and plating of deck abreast trunk of transversely framed trunk deck tankers

(Part only shown)

Table 6.3.3 Hull envelope plating - Trunk deck tankers trunk plating and deck plating

Item and parameter	Longitudinal framing		Transverse framing	
(1) Trunk deck plating Thickness *See* Note	The greater of: ~~$t_{trd} = (5{,}6 + 0{,}039L)\sqrt{s_t}$ mm~~ t_{trd} = 10s_t mm	$t_{\mathrm{trd}} = (5{,}6 + 0{,}039L)\sqrt{ks_{\mathrm{t}}}$ mm	The greater of: ~~$t_{trd} = (5{,}6 + 0{,}039L)\sqrt{s}$ mm~~ t_{trd} = 10s_t mm	$t_{\mathrm{trd}} = (5{,}6 + 0{,}039L)\sqrt{ks_{\mathrm{t}}}$ mm
	~~but for ships with a length, L, exceeding 40 m, ttrd is to be not less than:~~			
	~~The greater of :~~ ~~$t_{trd} = 0{,}076\frac{M}{B_{trd}\times D_{rtd}} - \frac{a1_{trd}}{10B_{trd}}$ mm~~ ~~$t_{trd} = 2{,}3\sqrt[3]{\frac{MH\times {s_t}^2}{B_{trd}\times D_{trd}}}$ mm~~		~~The greater of :~~ ~~$t_{trd} = 0{,}076\frac{M}{B_{trd}\times D_{trd}}$ mm~~ ~~$t_{trd} = 2{,}3\sqrt[3]{\frac{MH\times s^2}{B_{trd}\times D_{trd}\times C_1}}$ mm~~	
Symbols				
L, *s* and *t* as defined in *Pt 4, Ch 6, 1.12 Symbols and definitions 1.12.1* ~~a_{1trd} = total area of deck longitudinals, in cm^2~~ ~~$C_1 = 1 + 3\left(\frac{s}{S}\right)^2$, where s/S is the ratio of the unstiffened bottom panel under consideration~~ ~~*M* = the greater of M_S and M_H~~ ~~*MH* = maximum design hogging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~ ~~*MS* = maximum design sagging bending moment, in tm, *see Pt 3, Ch 4 Longitudinal Strength*~~				

■ *Section 4*
Hull envelope framing – Transversely framed ships

4.1 General

(Part only shown)

Table 6.4.1 Hull framing - Transversely framed ships

Item	Parameter	Requirement	
Floors	Modulus Web thickness	$Z = 6{,}6ks\,l_f^2\,h_b$ cm^3 $d_f \geq 30B$ mm ~~$t = 0{,}01d_f + 2$ mm~~	$t = (0{,}01d_{\mathrm{f}} + 2)\sqrt{k}$ mm
Centre girder	Web depth Web and face plate thickness Face plate width	$d = d_f$ mm ~~$t = 0{,}01d_f + 2$mm~~ w = 140s mm	$t = (0{,}01d_{\mathrm{f}} + 2)\sqrt{k}$ mm

Side frames in cargo tanks (single skin)	Modulus	$Z = 7k s l_e^2 h_g$ cm^3
Side frames in double skin	Modulus	$Z = 6{,}6k s l_e^2 h_f$ cm^3
Deck beams	Modulus	$Z = 6{,}6k s l_e^2 h_g$ cm^3
Deck girders	Modulus	$Z = (0{,}7 + 0{,}132L_1) k s l_e^2 h_g$ cm^3 *See* Note 1
Deck beams on trunk deck	Modulus	$Z_{tdb} = 6{,}6k s l_e^2 h_g$ cm^3
Trunk side stiffeners and deck beams abreast trunk	Modulus	$Z = Z_{tdb}$ cm^3
Stringers in cargo tanks (single skin)	Modulus	$Z = 6{,}6k l_s^2 S h_g$ cm^3
Stringers in double skin	Modulus	$Z = 6{,}6k l_s^2 S h_f$ cm^3
Symbols		
L, B, D, T, S, s, l_e, h_d, Z, I, ρ, k and ~~t~~ t are as defined in *Pt 4, Ch 6, 1.12 Symbols and definitions 1.12.1* h_b = the greater of: = (a) the depth, D, but need not ~~to~~ be taken greater than T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, T + 1,0 m for Zone 1 = (b) $h_g - 0{,}4T$ m D_2 = D, but need not be taken greater than T + 0,4 m for Zone 3, T + 0,7 m for Zone 2, T + 1,0 m for Zone 1		

4.9 Double bottom arrangements

(Part only shown)

Table 6.4.2 Double bottom (transverse framing)

Item	Parameter	Requirement	
(2) Centre girder and side girder	Thickness	~~$t = 0{,}01d_f + 1$mm~~	$t = (0{,}01d_f + 1)\sqrt{k}$ mm
(3) Floors	Thickness	~~$t = 0{,}009d_f + 1$ mm~~	$t = (0{,}009d_f + 1)\sqrt{k}$ mm
(4) Watertight floors and floors in line with web frames	Thickness	~~$t = 0{,}009d_f + 1$ mm~~	$t = (0{,}009d_f + 1)\sqrt{k}$ mm

■ *Section 5*

Hull envelope framing – Longitudinally framed ships

5.1 General

(Part only shown)

Table 6.5.1 Hull framing - Longitudinally framed ships - Secondary structure

Item	Parameter	Requirement (~~See~~ *See* Notes 1 and 2)	
Bottom longitudinals single skin	Modulus	$Z = K\,[0{,}34 + 0{,}46h_b + L_1\,(0{,}112 - 0{,}009h_b)]\,h_b k s l_e^2$ cm^3	
Bottom longitudinals ~~D~~double skin	Modulus	$Z = (3{,}95 + 0{,}04L_1)D_2 k s l_e^2$ cm^3	
Inner bottom longitudinals ~~D~~double skin	Modulus	$Z = 6k s l_e^2 h_g$ cm^3	
Side longitudinals single skin	Modulus	$Z = (4 + 0{,}04L_1) k s l_e^2 h_g$ cm^3	
Side longitudinals double skin	Modulus	$Z = (4{,}6 + 0{,}0342L_1) k s l_e^2 h_f$ cm^3	
Deck ~~trunkside~~ trunk side and trunk deck longitudinals	Modulus Inertia	$Z = [h_g - 3 + (0{,}18 - 0{,}02h_g) L_1] h_g k s l_e^2$ cm^3	
		~~$I = 2{,}3l_e Z$ cm^4~~	$I = \frac{2{,}3}{k} l_e Z$ cm^4

(Part only shown)

Table 6.5.2 Hull framing - Longitudinally framed ships - Primary structure

Item	Parameter	Requirement
Bottom transverses	Modulus	$Z = 6{,}6kS l_e^2 h_b$ cm^3
Side transverses	Modulus	$Z = 10kS l_e^2 h_g$ cm^3
Deck and trunk deck transverses	Modulus	The greater of: $Z_b = 6{,}6kS l_e^2 h_g$ cm^3 $Z_b = 4{,}3kS l_e$~~2~~$^2 h_t$ cm^3

5.6 Double bottom arrangements

(Part only shown)

Table 6.5.3 Double bottom (longitudinal framing)

~~Location~~ Item	~~Scantlings~~ Parameter	Requirements
(2) Centre girder and side girder	Thickness	~~$t = 0{,}01d_f + 1$ mm~~ $t = (0{,}01d_f + 1)\sqrt{k}$ mm
(3) Floors, watertight floors and floors in line with web frames	Thickness	~~$t = 0{,}009d_f + 2$ mm~~ $t = (0{,}009d_f + 2)\sqrt{k}$ mm

■ *Section 7*
Longitudinal and transverse bulkheads of integral cargo tanks

7.1 General

(Part only shown)

Table 6.7.1 Scantlings of plane and corrugated transverse and longitudinal bulkheads of integral cargo tanks

Item	Parameter	Requirement
Stringers and webs supporting stiffeners	Modulus	$Z =$ ~~6,6~~ $8{,}5k S l_e^2 h_g$
Symbols		
Z, I, S, t, s, l_e, ρ, k and h_d are as defined in *Pt 4, Ch 6, 1.12 Symbols and definitions 1.12.1* ~~$k = \frac{235}{\sigma_0}\left(\frac{24}{\sigma_0}\right)$ or 0,66, whichever is the greater~~ ~~= where~~ ~~σ_0 = specific minimum yield stress in N/mm^2 (kgf/mm^2)~~ K_C = The lesser of 1,5 or d_t in *Pt 3, Ch 4, 7.3 Corrosion additions* for mild steel, ~~for solid stainless steel~~, *see* ~~*Table 6.7.2 Values of plate thickness factor K_C*~~ *Pt 3, Ch 4, 7.3 Corrosion additions 7.3.7* for solid stainless steel		

Existing Table 6.7.2 Values of plate thickness factor K_c for solid stainless steel has been deleted.

7.2 Stainless steel

7.2.2 The thickness of plating forming boundaries of cargo tanks is to be in accordance with the requirements given in *Pt 4, Ch 6, 7.1 General*. ~~For stainless steel the plate thickness factor, K_C, depends on the position of the material, relative to the designation of the adjacent space. *See Table 6.7.2 Values of plate thickness factor K_c for solid stainless steel*.~~

■ *Section 11*
Miscellaneous

11.2 Pillar bracket inside the cargo tank

11.2.1 Where the deck transverse and bottom floor are supported by the pillar, the pillar is to be verified by direct calculations considering the service, test and vacuum conditions.

11.2.2 In between pillars, pillar brackets and pillar brackets, inner bottoms, the shear area are to be verified by direct calculations considering the axial force from the pillar. For permissible stresses, *see Pt 4, Ch 6, Table 6.12.2 Maximum permissible stresses in local members, in N/mm^2*.

11.2.3 Where the length of the free edge of a bracket exceeds 50t mm, edge stiffening is to be fitted or the thickness is to be suitably increased.

■ *Section 12*
Direct calculation procedures

12.2 Loads

(Part only shown)

Table 6.12.1 Maximum permissible stresses in longitudinal continuous members, in N/mm²

Item	Local bending stress, σ_b	Combined bending stress, σ_c *See* Note 1	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e *See* Note 2
Bottom and deck girders in ~~transversely-framed~~ transversely framed ships	~~110~~ $0{,}46\sigma_L$	~~180~~ $0{,}75\sigma_L$	~~85~~ $0{,}35\sigma_L$	~~190~~ $0{,}80\sigma_L$
Bottom, deck and side longitudinals	~~140~~ $0{,}58\sigma_L$	~~180~~ $0{,}75\sigma_L$	~~85~~ $0{,}35\sigma_L$	~~190~~ $0{,}80\sigma_L$
Symbols				
Where $\sigma_L = 235/k_L$ Note *1.* The combined stress, σ_c, is the sum of the stresses due to longitudinal bending and local loading.				

(Part only shown)

Table 6.12.2 Maximum permissible stresses in local members, in N/mm² ~~(kgf/mm²)~~

Item	Bending stress, σ_b	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e *See* Note
Floors, bottom transverses, non-continuous bottom girders, side stringers, deck beams, deck transverses and non-continuous deck girders	~~124 (12,6)~~ $0{,}53\sigma_o$	~~83 (8,5)~~ $0{,}35\sigma_o$	~~177 (18,0)~~ $0{,}75\sigma_o$
Side frames	~~113 (11,5)~~ $0{,}48\sigma_o$	~~83 (8,5)~~ $0{,}35\sigma_o$	~~172 (17,5)~~ $0{,}73\sigma_o$
Webs supporting side stringers, side transverses	~~103 (10,5)~~ $0{,}43\sigma_o$	~~83 (8,5)~~ $0{,}35\sigma_o$	~~167 (17,0)~~ $0{,}71\sigma_o$

Part 4,
Chapter 8
Tugs, Pusher Tugs and Launches

■ *Section 7*
Direct calculation procedures

7.2 Permissible stresses

Table 8.7.1 Maximum permissible stresses in local members in bottom and deck, in N/mm²

Item	Bending stress, σ_b	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e ~~See~~ *See* Note
Bottom transverses, bottom girders, deck girders, deck transverses	~~124 (12,6)~~ $0{,}52\sigma_o$	~~83 (8,5)~~ $0{,}35\sigma_o$	~~177 (18,0)~~ $0{,}75\sigma_o$

Deck beams, floors, deck longitudinals, bottom longitudinals	~~137 (14,0)~~ $0{,}58\sigma_o$	~~83 (8,5)~~ $0{,}35\sigma_o$	~~186 (19,0)~~ $0{,}80\sigma_o$

Part 4,
Chapter 9
Passenger Ships

■ *Section 1*
General

1.1 Application

1.1.5 ~~The requirements in this Chapter are based on the following international regulations:~~

- ~~The Rhine Inspection Regulations of the Central Rhine Commission (CCNR), in particular Chapter 15, concerning special requirements applicable to Passenger Vessels.~~
- ~~The Directive of the European Parliament and of the Council of 12 December 2006 laying down technical requirements for inland waterway vessels, in particular Chapter 15, concerning special requirements applicable to Passenger Vessels.~~

The requirements in this Chapter are based on the European Standard laying down Technical Requirements for inland Navigation Vessels (ES-TRIN), in particular Chapter 19, concerning special requirements applicable to Passenger Vessels.

1.4 Ship arrangement – Subdivision and transverse bulkheads

1.4.2 The distance between the collision bulkhead and the forward perpendicular shall be at least $0{,}04L_{WL}$ and not more than $0{,}04L_{WL} + 2$ m. If the distance exceeds $0{,}04L_{WL} + 2$ m, compliance with *Pt 3, Ch 7, 1.3 Collision bulkhead 1.3.1* shall be proven by direct calculations.

1.4.3 The distance from the F.P. may be reduced to $0{,}03L$, in which case the requirement of *Pt 3, Ch 7, 1.3 Collision bulkhead 1.3.1* shall be proven by direct calculations based on the flooding of both the fore peak and those compartments directly aft of and adjacent to the collision bulkhead.

Existing paragraphs 1.4.3 to 1.4.8 have been renumbered 1.4.4 to 1.4.9.

1.14 Symbols and definitions

(Part only shown)
1.14.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

~~L, B, D, T, = for calculations of scantlings, as defined in *Pt 3, Ch 1, 6.1 Principal particulars*~~
~~C_b~~
L, B, D, T and C_b = for calculation of scantlings, as defined in *Pt 3, Ch 1, 6.1 Principal particulars*

k_L = *Pt 3, Ch 2, Table 2.1.1 Values of* k_L
k = higher tensile steel factor, *see* *Pt 3, Ch 2, 1.3 Steel 1.3.3*

■ *Section 3*
Longitudinal strength

3.1 General

3.1.1 For the assessment of the required longitudinal strength which is to be maintained over the midship region, design bending moments are to be calculated. The design bending moments, sagging and hogging, are the maximum moments occurring when the ship is in any condition indicated in ~~3.1.5~~ *Pt 4, Ch 9, 3.1 General 3.1.5* and are to be calculated and verified for ships of a length, L, of more than ~~40~~ 65 m and for all ships of unusual type.

3.1.4 For maximum permissible stresses, *see* ~~*Pt 3, Ch 4, 6 Maximum permissible stresses*~~ *Pt 3, Ch 4, 6.5 Permissible hull vertical bending stresses*.

3.1.5 The following loading conditions for determination of design bending moments are to be covered:
(a) Departure condition:

Ship completely equipped, fresh water, fuel and lubricating oil tanks full, the maximum allowed number of passengers, crew and stores on board and ballast tanks ~~partly or completely filled~~ are to be considered as either empty or full in accordance with the actual condition.
(b) Arrival condition:
Ship completely equipped, fresh water, fuel and lubricating oil tanks 95 per cent empty and ballast tanks ~~partly or completely filled~~ are to be considered as either empty or full in accordance with the actual condition.

■ *Section 4*
Shell envelope plating

4.1 General

4.1.2 The thickness of the shell envelope plating is to be not less than required in *Table 9.4.1 Shell envelope plating*, but for ships over ~~40~~ 65 m in length the thickness of the bottom plating may require to be increased to meet the requirements of *Pt 4, Ch 9, 3 Longitudinal strength*.

(Part only shown)

Table 9.4.1 Shell envelope plating

Item and parameter	Requirements	
(2) Bottom plating Thickness	The greater of: ~~$t_\mathrm{b} = (5,6 + 0,054L)\sqrt{s}$ mm~~	$t_\mathrm{b} = (5,6 + 0,054L)\sqrt{ks}$ mm
	t~~$_\mathrm{b}$~~ = 10s mm ~~but for ships with a length, L, greater than 40 m, t_b is to be not less than:~~ ~~Longitudinally framed bottom plating:~~ ~~$t_b = 2,6\sqrt[3]{\frac{MH \times s^2}{B \times D}}$~~ ~~Transversely framed bottom plating:~~ ~~$t_b = 3,85\sqrt[3]{\frac{MH \times s^2}{B \times D}}$~~	
(5) Side shell plating Thickness	The greater of: ~~$t_\mathrm{b} = (5,6 + 0,054L)\sqrt{s}$ mm~~	$t_\mathrm{b} = (5,6 + 0,054L)\sqrt{ks}$ mm
	~~t~~ t_b= 10s mm	
Symbols		
L, B, D, S, s, k and t are as defined in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1* ~~MH = design hogging bending moment as calculated according to *Pt 4, Ch 9, 3.1 General 3.1.3*, in tm~~		

■ *Section 5*
Deck plating

5.2 Thickness of deck plating

5.2.1 The deck plating thickness is to be not less than as required in *Table 9.5.1 Deck plating*, but for ships of a length, L, of ~~40~~ 65 m and over the deck plating may require to be increased to meet the requirements of *Pt 4, Ch 9, 3 Longitudinal strength*.

(Part only shown)

Table 9.5.1 Deck plating

Item and parameter	Requirements	
Deck plating Thickness	The greater of: ~~$t = (5,6 + 0,039L)\sqrt{s}$ mm~~	The greater of: $t = (5,6 + 0,039L)\sqrt{ks}$ mm
	t = 10s mm ~~but for ships with a length, L, greater than 40 m, t is to be not less than:~~ ~~Longitudinally framed deck plating:~~ ~~$t = 0,076\frac{M}{B \times D} - \frac{a_1}{10B}$ mm~~ ~~Transversely framed deck plating:~~ ~~$t = 0,076\frac{M}{B \times D}$ mm~~	

■ *Section 6*
Single bottom structure

6.1 General

6.1.4 The bottom structure of ships of a length, *L*, longer than 110 m is to have the double bottom structure according to *Pt 4, Ch 9 7.1 General 7.1.7*.

(Part only shown)

Table 9.6.1 Transversely and longitudinally framed single bottom

Item	Parameter	Requirements
Longitudinal and transverse framing system		
Centreline and side girders	Web and face plate thickness	~~$t = 0{,}01 d_{w} + 2$ mm~~ $t = (0{,}01 d_{w} + 2)\sqrt{k}$ mm
Transverse framing system		
Floors	Web thickness Minimum required modulus	~~$t = 0{,}01 d_{w} + 2$ mm~~ $t = (0{,}01 d_{w} + 2)\sqrt{k}$ mm $Z = 6{,}6 k B^{2}$ ~~D~~ D_{1}-s cm^{3}
Longitudinal framing system		
Bottom transverses Bottom longitudinals	Web thickness Modulus Modulus Inertia	~~$t = 0{,}01 d_{w} + 3$ mm~~ $t = (0{,}01 d_{w} + 3)\sqrt{k}$ mm $Z = 6{,}6 k B^{2}$ ~~D~~ $D_{1} S$ cm^{3}
		~~$Z = (3{,}95 + 0{,}04 L_{1}) D_{1} s {l_{e}}^{2}$ cm^{3}~~ $Z = (3{,}95 + 0{,}04 L_{1}) D_{1} k s {l_{e}}^{2}$ cm^{3}
		~~$I = 2{,}3 l_{e} Z$ cm^{4}~~ $I = \frac{2{,}3}{k} l_{e} Z$ cm^{4}
Symbols applying to *Table 9.6.1 Transversely and longitudinally framed single bottom* and *Table 9.7.1 Transversely and longitudinally framed double bottom*		
~~*L*, *B*, *D*, *T*, *s*, *S*, = as defined in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1*~~ ~~*t*, *I*, *k*, *Z* and l_e~~ *L*, *B*, *D*, *T*, *s*, *S*, *t*, *I*, *k*, *Z* and l_e are as defined in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1* $D_{-1} = D$, but need not be taken ~~as not~~ greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1		

■ *Section 7*
Double bottom structure

7.1 General

(Part only shown)

Table 9.7.1 Transversely and longitudinally framed double bottom

Item	Parameter	Requirements
Longitudinal and transverse framing system		
Centreline and side girders	Web thickness	~~$t = 0{,}01 \mathrm{d}_{f} + 2$~~ $t = (0{,}01 \mathrm{d}_{w} + 2)\sqrt{k}$ mm
Transverse framing system		
Plate floors and brackets of bracket floor	Web thickness	The greater of: ~~$t = 0{,}008 \mathrm{d}_{f} + 1{,}5$ mm~~ $t = (0{,}008 d_{f} + 1{,}5)\sqrt{k}$ mm
Bracket floors: bottom frames reverse frames	Modulus Modulus	*t* = 5,5 mm
		~~$Z = 6{,}6 D_{1} l_{e} 2$ cm^{3}~~ $Z = 6{,}6\ ks$-$D_{1}\ l_{e}\ 2^{2}$ cm^{3}
		~~$Z = 5{,}6 D_{1} l_{e} 2$ cm^{3}~~ $Z = 5{,}6\ ks\ D_{1}\ l_{e}^{2}$
Longitudinal framing system		
Plate floors Double bottom longitudinals	Web thickness Modulus	~~$t = 0{,}009 \mathrm{d}_{f} + 1{,}5$ mm~~ $t = (0{,}01 \mathrm{d}_{w} + 1{,}5)\sqrt{k}$ mm ~~$Z = 6 s D_{1} {l_{e}}^{2}$ cm^{3}~~ $Z = 6ksD_{1}$-l_{e}^{2} cm^{3}

7.1.7 Passenger ships of a length, *L*, longer than 110 m are to:

(a) have a double bottom with a height of at least 600 mm and subdivision to ensure that, in the event of flooding of any two adjacent watertight compartments, the vessel does not immerse lower than the margin line and a residual safety clearance of 100 mm remains, or have a double bottom with a height of at least 600 mm and a double hull with a distance of at least 800 mm between the side wall of the vessel and the longitudinal bulkhead;

(b) be fitted with a multi-propeller propulsion system with at least two independent engines of equal power and a bow thruster system which can be operated from the wheelhouse and which operates longitudinally as well as transversely.

7.1.8 A double bottom is required according to *Pt 4, Ch 9, 7.1 General 7.1.7*. The double bottom is to be fitted extending from the collision bulkhead to the after peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

■ *Section 8*
Shell envelope framing

8.1 General

(Part only shown)

Table 9.8.1 Shell side frames and longitudinals

Location	Modulus	
Clear of tanks Frames	~~$Z_{F} = 1{,}2D_{1}s\,(2{,}5H^{2} + 0{,}03B^{2} + 6)$ cm^3~~	$Z\text{-}_{F} = 1{,}2D\text{-}_{1}ks\text{-}(2{,}5H^{2} + 0{,}03B^{2} + 6)$ cm^3
Side shell longitudinals	~~$Z_{SL} = 6s\,l_e^{2}\,h_{5} + 4$ cm^3~~	$Z\text{-}_{SL} = 6ks\text{-}l_e^{2}\text{-}h_{5} + 4$ cm^3
In way of O.F. or water tanks Frames	The greater of: $Z\text{-}_{TF} = Z\text{-}_{F}$ $Z\text{-}_{TF} = 4{,}3ks\text{-}l_e^{2}\text{-}h\text{-}_{4} + 4$ cm^3	
Side shell longitudinals	The greater of: $Z\text{-}_{TSL} = Z\text{-}_{SL}$ $Z\text{-}_{TSL} = 4{,}3ks\text{-}l_e^{2}\text{-}h\text{-}_{4} + 4$ cm^3	
Symbols		
L, *B*, *s*, *k* and *Z* = as defined in~~*Pt 4,*~~ in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1* D_{1} = *D*, but need not be taken ~~as not~~ greater than *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1 $h\text{-}_{5}$ = load head, in metres, measured vertically from the middle of the effective length to the deck at side or to a point *T* + 0,4 m for Zone 3, *T* + 0,7 m for Zone 2, *T* + 1,0 m for Zone 1 above baseline, whichever is the lesser, but to be taken as not less than 1,5 m		

■ *Section 9*
Deck structure

9.1 Deck supporting structure

(Part only shown)

Table 9.9.1 Deck supporting structure

Item	Modulus
Transverse deck beams	$Z\text{-}_{TD} = 4{,}3ksl_e^{2}\text{-}h\text{-}_{1} + 4$ cm^3
Transverse beams in way of crown of tank	$Z\text{-}_{TDCT} = 4{,}3ksl_e^{2}\text{-}h\text{-}_{2} + 4$ cm^3
Deck longitudinals	$Z\text{-}_{DL} = 4{,}3ksl_e^{2}\text{-}h\text{-}_{1} + 4$ cm^3
Deck longitudinals in way of crown of tank	$Z\text{-}_{DLCT} = 4{,}3ksl_e^{2}\text{-}h\text{-}_{2} + 4$ cm^3

Item	Parameter	Requirements	
Girders and transverses in dry spaces	Modulus	$Z = 4{,}75kh_{1}\text{-}Sl_e^{2}$ cm^3	
Pillars in dry spaces, *see* Note	Inertia	~~$I = 2{,}3l_e\text{-}Z$ cm^4~~	$I = \frac{2{,}3}{k} l_e Z$ cm^4
Symbols			
~~*L*, *s*, *S*, *Z*, = as defined in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1*~~ ~~*I* and *t*~~ *L*, *s*, *S*, *Z*, *I*, *k* and *t* are as defined in *Pt 4, Ch 9, 1.14 Symbols and definitions 1.14.1*			

■ *Section 10*
Erections

10.1 General

10.1.2 Where an erection is fitted complying with *Pt 4, Ch 9, 3.1 General 3.1.6* the thickness of the deck plating is to comply with the requirements of *Table 9.10.1 Deck plating of effective superstructures and deckhouses*, but on ships having a length of ~~40~~ 65 m and over the thickness may require to be increased to meet the requirements of *Pt 4, Ch 9, 3 Longitudinal strength*.

■ *Section 11*
Direct calculation procedures

11.2 Permissible stresses

(Part only shown)

Table 9.11.1 Maximum permissible stresses in longitudinal continuous members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Local bending stress, σ_b	Combined bending stress, σ_c ~~*see*~~ *See* Note 1	Shear stress, ~~τ~~ τ	Equivalent stress, σ_e *See* Note 2
Bottom girders	~~108(11,0)~~ 0,46σ_L	~~177(18,0)~~ 0,75σ_L	~~83(8,5)~~ 0,35σ_L	~~188(19,2)~~ 0,80σ_L
Bottom longitudinals Inner bottom longitudinals Side shell longitudinals	~~137(14,0)~~ 0,58σ_L	~~177(18,0)~~ 0,75σ_L	~~83(8,5)~~ 0,35σ_L	~~188(19,2)~~ 0,80σ_L
Symbols				
Where $\sigma_L = 235/k_L$ Note *1.* The combined stress σ_c is the sum of the stresses due to longitudinal bending and local loading.				

(Part only shown)

Table 9.11.2 Maximum permissible stresses in local members, in N/mm^2 ~~(kgf/mm^2)~~

Item	Bending stress, ~~σb~~ σ_b	Shear stress, τ	Equivalent stress, ~~σe~~ σ_e *See* Note
Floors, non-continuous girders, bottom and deck, deck transverses, bottom transverses	~~124 (12,6)~~ 0,53σ_o	~~83 (8,5)~~ 0,35σ_o	~~177 (18,0)~~ 0,75σ_o
Frames	~~113 (11,5)~~ 0,48σ_o	~~83 (8,5)~~ 0,35σ_o	~~172 (17,5)~~ 0,73σ_o
Deck beams	~~137 (14,0)~~ 0,58σ_o	~~83 (8,5)~~ 0,35σ_o	~~186 (19,0)~~ 0,79σ_o

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